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Energy Research Abstracts

Abstracts 46790–48754

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UNITED STATES DEPARTMENT OF ENERGY

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Energy Research Abstracts

Purpose

Energy Research Abstracts (ERA) provides abstracting and indexing coverage of all scientific and technical reports, journal articles, conference papers and proceedings, books, patents, theses, and monographs originated by the U.S. Department of Energy, its laboratories, energy centers and contractors. *ERA* also covers other energy information prepared *in report form* by federal and state government organizations, foreign governments, and domestic and foreign universities and research organizations. Foreign information is obtained through the International Energy Agency's 14-nation Energy Technology Data Exchange, the International Atomic Energy Agency's International Nuclear Information System, or nation-to-nation agreements. **Please note that *ERA* coverage of non-report literature is limited to that generated by Department of Energy activity.**

Scope

ERA is comprehensive in its subject scope, encompassing DOE's research, development, demonstration, and technological programs resulting from its broad charter for energy sources, supplies, safety, environmental impacts, and regulation.

The citations presented in *ERA* are available for on-line searching as records within the Energy Data Base. The current-year records are available on the Integrated Technical Information System (ITIS). The entire data base is available through commercial on-line vendors.

Availability

DOE and DOE contractors who have OSTI deposit accounts can obtain *ERA* (regular issues and annual indexes) from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831, Attention: Information Services. For further information, call (615)576-8401, FTS 626-8401. *ERA* is also available at authorized GPO Depository Libraries. (List is provided on the inside back cover.)

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Managing Editor, Audrey B. Smith
Technical Editor, M. Catherine Grissom

Information Sources

The citations presented in *Energy Research Abstracts* are a subset of the worldwide energy information provided to the Office of Scientific and Technical Information (OSTI) through exchange agreements with foreign sources and through exchanges or contracts with U.S. organizations.

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- Sweden
- Switzerland
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The **International Nuclear Information System (INIS)** was established to promote the exchange of information on nuclear science and technology. Its operation is similar to that of the ETDE, with the INIS Secretariat being located in Vienna, Austria. Currently, 75 countries and 14 international organizations are members of INIS. OSTI serves as the INIS national center for the United States.

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5. **Author affiliation.** Only first one is listed, in parentheses after author(s) to which it applies.
6. **Collaboration,** if present.
7. **Corporate author(s)** identifying corporation responsible for document.
8. **Patent assignee and number** for citations of patent documents or applications.
9. **Journal title, volume, and issue** for citations of journal articles.
10. **Date of publication.** If not known, a processing date is in brackets.
11. **Number of pages** or page range.
12. **Language** of document if non-English.
13. **Monograph title** if citation is an analytic (part, chapter, or paper) of a larger monograph.
14. **Publisher's name and location** for documents published by a corporate or commercial source.
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16. **Contract or grant number.**
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18. **Conference title, location, and date,** if applicable.
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20. **Sources of availability** from which a copy of the document may be obtained; usually appear as abbreviations. (See information on following page.)
21. **Drop note** or explanatory statement.
22. **Abstract.**
23. **Subject descriptors.** Listed only if no abstract or only a brief statement is included.

Sample Citations

Report

18494 (DOE/ER/40438–T1) **[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report.** Haeberli, W. Phys. VI collaboration. Wisconsin Univ., Madison (USA). Dept. of Physics. [1989]. 12p. Sponsored by DOE Energy Research. DOE Contract FG02-88ER40438. Order Number DE89007246/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper briefly discusses the Wisconsin test facility for storage cells; results of target tests; the new UHV...

Report Analytic

18500 (INIS-SU—69, pp. 30-32) **Transition energies in Ne-like ions. Correlation effects.** Vainshtejn, L.A. AN SSSR, Moscow. Fizicheskij Inst. 1988. (In Russian). In *Experimental and theoretical physics. Collection.* Order Number DE89780060/JAW. Available from NTIS (US Sales Only), PC A03/MF A01; INIS.

Kratkie Soobshcheniya po Fizike.; no. 6.

SILVER IONS/energy-level transitions; XENON IONS/energy-level transitions; CORRELATIONS; D STATES; E STATES;...

Journal Article

19055 **A theoretical and experimental investigation of long-pulse, electron-beam-produced rare gas plasmas.** Brake, M.L.; Repetti, T.E. (Energy Beam Interaction Lab. of the Dept. of Nuclear Engineering, Univ. of Michigan, Ann Arbor, MI (US)). *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Plasma Science (USA),* 16(5): 581-589 (Oct 1988). (CONF-881020–: Symposium on radiation physics, Sao Paulo, Brazil, October 3, 1988).

Visible emission spectroscopy (380-650 nm) has been performed on intense, electron beam (1 kA, 300 ns, 300 kV) produced Ar, Kr,...

Patent

18045 **Polarization of fast particle beams by collisional pumping.** Stearns, J.W. To Dept. of Energy, Washington, DC. USA Patent 4,724,117. 9 Feb 1988. Filed date 19 Oct 1984. vp. Available from Patent and Trademark Office, Box 9, Washington, DC 20232.

A method for polarizing a fast beam of particles by collisional pumping, comprising the steps of generating a beam...

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Report literature, usually identified by an alphanumeric identifier at the beginning of a citation, is available from the sources listed in the citation (see example of element 20 on page iii). Often the sources are listed as abbreviations. Corresponding addresses are provided at right from which documents with these abbreviations may be ordered. When "OSTI" is given, **DOE and DOE contractors may order these documents from OSTI.** (However, check with your library or information organization which may require that orders go through them to OSTI.) The public should order from NTIS or from one of the other agencies listed in the citation. To expedite processing, an order form is provided in the back of this publication. NOTE: The order numbers provide quicker access for report ordering. Use the order number where possible.

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NTIS U.S. Department of Commerce
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Books, conferences, and monographs The source for these publications is the publisher or the originating society, organization, or institution. DOE-supported conferences and individual papers reporting DOE-supported research may be available as reports from OSTI.

Foreign material The Linda Hall Library is an excellent source of foreign materials. For translations of foreign language material, contact the John Crerar Library. For material difficult to locate, check with the British Library Document Supply Centre.

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Five indexes are provided for approaching the content of each issue of *Energy Research Abstracts*. Descriptions of entries in these indexes follow.

Corporate Author Index
The corporation, organization, or institution responsible for the issuance of the document is listed in this index. The entries are arranged alphabetically and provide the title and citation number of the reference. For example, the listing for the "Report" sample citation would appear as shown at right.

Wisconsin Univ., Madison (USA). Dept. of Physics
[Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 14:18494 (R;US)
Wisconsin Univ., Madison (USA). Lab. of Genetics
Organization of the R chromosome region in maize: Final progress report, June 1, 1983–May 31, 1986, 14:18255 (R;US)

Personal Author Index
Each author's name listed on a document cited in this issue is indexed. An index entry provides title and citation number; for secondary and other names, a cross-reference is given to the primary author name where the full index entry is located.

Hadley, D.L., *See* Lee, A.D., 14:17651
Haeberli, W., [Development of a hydrogen and deuterium polarized gas target for application in storage rings]: Progress report, 14:18494 (R;US)

Subject Index
This index lists the main subject descriptors assigned to each record by indexing professionals. A secondary or qualifier term is used where necessary to describe materials, objects, and processes. Document titles may be enhanced with additional informative phrases where necessary. An excerpt from this index appears at right.

HYDROGEN ISOTOPES
See also DEUTERIUM
HYDROGEN 4
TRITIUM
Neutron-Rich Isotopes
Study on the strong neutron-rich nuclei of lightest elements, 14:18686 (RA;SU;In Russian)

Contract Number Index
DOE technical reports are listed by contract number. Each entry also provides the primary corporation or organization cited for that contract number. A typical entry is shown.

FG02-88ER40438 **Wisconsin Univ., Madison (USA). Dept. of Physics**
14:18494 DOE/ER/40438–T1
FG02-88ER60664 **Rogers and Associates Engineering Corp., Salt Lake City, UT (USA)**
14:17641 DOE/ER/60664–1

Report Number Index
Technical report literature is indexed by the alphanumerical identifier of the report. Patent documents and conferences are included for convenience. Each entry lists the citation number, the source of availability of the document, an indicator of presence at a GPO depository library, order number, and distribution category. A typical entry is:

DOE/ER/40438–T1 14:18494 NTIS, PC A03/MF A01 - OSTI E 1.99: DE89007246/JAW MF-411

Subject Contents

The subject content of *Energy Research Abstracts* is arranged as shown below. The two-digit and four-digit category numbers printed here illustrate the category number assignment used in the data base records.* The following list includes all of the 40 first-level and the 289 second-level categories. Because each issue of *ERA* publishes citations only for those documents announced during the past semimonthly period, some subject categories may not be present in every issue.

Numerical Listing of Categories

01 COAL AND COAL PRODUCTS
- 03 Preparation
- 04 Processing
- 05 By-Products
- 06 Properties
- 08 Waste Management
- 09 Environmental Aspects
- 10 Reserves and Exploration
- 20 Mining
- 30 Transport and Handling
- 40 Combustion
- 50 Marketing and Economics
- 60 Health and Safety
- 70 Legislation and Regulations

02 PETROLEUM
- 01 Reserves
- 02 Geology and Exploration
- 03 Drilling and Production
- 04 Processing
- 05 Products and By-Products
- 06 Health and Safety
- 07 Marketing and Economics
- 08 Waste Management
- 09 Environmental Aspects
- 10 Legislation and Regulation
- 20 Transport, Pipelines, and Handling
- 30 Properties
- 40 Storage
- 50 Combustion

03 NATURAL GAS
- 01 Reserves
- 02 Geology and Exploration
- 03 Drilling, Production, and Processing
- 04 Products and By-Products
- 05 Health and Safety
- 06 Marketing and Economics
- 07 Waste Management
- 08 Environmental Aspects
- 09 Artificial Stimulation
- 10 Legislation and Regulation
- 20 Transport, Pipelines, and Handling
- 30 Properties
- 40 Combustion
- 50 Storage

04 OIL SHALES AND TAR SANDS
- 01 Reserves and Exploration
- 02 Site Geology and Hydrology
- 03 Drilling, Fracturing, and Mining
- 04 Oil Production, Recovery, and Refining
- 05 Properties and Composition
- 06 Direct Uses and By-Products
- 07 Health and Safety
- 08 Marketing and Economics
- 09 Waste Research and Management
- 10 Environmental Aspects
- 20 Regulations

05 NUCLEAR FUELS
- 01 Reserves, Exploration, and Mining
- 04 Feed Processing
- 05 Uranium Enrichment
- 07 Fuels Production and Properties
- 08 Spent Fuels Reprocessing
- 09 Transport and Storage
- 10 Marketing, Economics, and By-Products
- 20 Waste Management
- 30 Environmental Aspects
- 40 Health and Safety
- 50 Safeguards, Inspection, and Accountability
- 60 Legislation and Regulations

07 ISOTOPE AND RADIATION SOURCE TECHNOLOGY
- 01 Physical Isotope Separation
- 02 Radiation Sources
- 03 Isotopic Power Supplies
- 04 Economics

08 HYDROGEN
- 01 Production
- 02 Storage
- 03 Transport
- 04 Marketing and Economics
- 05 Safety
- 06 Industrial and Commercial Use
- 07 By-Products
- 08 Properties
- 09 Environmental Aspects

09 OTHER SYNTHETIC AND NATURAL FUELS
- 01 Hydrocarbon Fuels
- 02 Alcohol Fuels
- 03 Inorganic Hydrogen Compound Fuels
- 04 Solid Waste and Wood Fuels
- 05 Liquid Waste Fuels
- 06 Gaseous Waste Fuels

13 HYDRO ENERGY
- 01 Resources and Availability
- 02 Site Geology and Meteorology
- 03 Plant Design and Operation
- 04 Regulations and Licensing
- 05 Economics and Management
- 06 Environmental Aspects
- 07 Power-Conversion Systems

14 SOLAR ENERGY
- 01 Resources and Availability
- 03 Economics
- 04 Environmental, Legal, and Institutional Aspects
- 05 Solar Energy Conversion
- 06 Photovoltaic Power Systems
- 07 Solar Thermal Power Systems
- 08 Ocean Energy Systems
- 09 Solar Thermal Utilization
- 10 Solar Collectors and Concentrators
- 20 Heat Storage

15 GEOTHERMAL ENERGY
- 01 Resource Status and Assessment
- 02 Geology and Hydrology of Geothermal Systems
- 03 Geothermal Exploration and Exploration Technology
- 04 Legal and Institutional Aspects

*The numerical subject category scheme is used in the storage, retrieval, and manipulation of bibliographic information entered into DOE's data systems. Categories and definitions for the complete set of six-digit numbers are given in DOE/TIC-4584, *Energy Data Base: Subject Categories and Scope*.

- 05 Economic and Financial Aspects
- 06 Environmental Aspects and Waste Disposal
- 07 By-Products
- 08 Geothermal Power Plants
- 09 Geothermal Engineering
- 10 Direct Energy Utilization
- 20 Geothermal Data and Theory

16 TIDAL AND WAVE POWER
- 03 Regulations
- 04 Economics
- 05 Environmental Aspects
- 07 Tidal Power Plants
- 08 Wave Energy Converters

17 WIND ENERGY
- 01 Availability (Climatology)
- 03 Regulations
- 04 Economics
- 05 Environmental Aspects
- 06 Wind Energy Engineering

20 ELECTRIC POWER ENGINEERING
- 01 Power Plants and Power Generation
- 02 Environmental Control Technology
- 03 Power Transmission and Distribution

21 NUCLEAR POWER PLANTS
- 01 Power Reactors, Nonbreeding, Light-Water Moderated, Boiling Water Cooled
- 02 Power Reactors, Nonbreeding, Light-Water Moderated, Non-boiling Water Cooled
- 03 Power Reactors, Nonbreeding, Graphite Moderated
- 04 Power Reactors, Nonbreeding, Otherwise Moderated or Unmoderated
- 05 Power Reactors, Breeding
- 06 Power Reactors, Auxiliary, Mobile, Package, and Transportable
- 07 Regulation and Licensing
- 08 Economics

22 NUCLEAR REACTOR TECHNOLOGY
- 01 Theory and Calculation
- 02 Components and Accessories
- 03 Fuel Elements
- 04 Control Systems
- 05 Environmental Aspects
- 06 Research, Test, and Experimental Reactors
- 07 Plutonium and Isotope Production Reactors
- 08 Propulsion Reactors
- 09 Reactor Safety

25 ENERGY STORAGE
- 01 Magnetic
- 02 Compressed Gas
- 03 Pumped Hydro
- 04 Capacitor Banks
- 05 Flywheels
- 06 Thermal
- 07 Liquefied Gas
- 08 Chemical
- 09 Batteries

29 ENERGY PLANNING AND POLICY
- 01 Energy Analysis and Modeling
- 02 Economics and Sociology
- 03 Environment, Health, and Safety
- 04 Natural Resources
- 05 Research, Development, Demonstration, and Commercialization
- 06 Nuclear Energy
- 07 Transport and Storage
- 08 Waste Heat Utilization
- 10 Conservation
- 20 Supply, Demand, and Forecasting
- 30 Policy, Legislation, and Regulation
- 40 Fossil Fuels
- 50 Hydrogen and Synthetic Fuels
- 60 Electric Power
- 80 Consumption and Utilization
- 90 Unconventional Sources and Power Generation

30 DIRECT ENERGY CONVERSION
- 01 MHD Generators
- 02 EHD Generators
- 03 Thermoelectric Generators
- 04 Thermionic Converters
- 05 Fuel Cells
- 08 Miscellaneous Converters

32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION
- 01 Buildings
- 02 Transportation
- 03 Industry and Agriculture
- 06 Municipalities and Community Systems
- 09 Education and Public Relations

33 ADVANCED AUTOMOTIVE PROPULSION SYSTEMS
- 01 Internal Combustion Engines
- 02 External Combustion Engines
- 03 Electric-Powered Systems
- 04 Hybrid Systems
- 05 Flywheel Propulsion
- 06 Vehicle Design Factors
- 07 Emission Control
- 08 Alternative Fuels

35 ARMS CONTROL
- 01 Policy, Negotiations, and Legislation
- 02 Proliferation
- 03 Verification

36 MATERIALS
- 01 Metals and Alloys
- 02 Ceramics, Cermets, and Refractories
- 06 Other Materials

40 CHEMISTRY
- 01 Analytical and Separations Chemistry
- 02 Inorganic, Organic, and Physical Chemistry
- 04 Electrochemistry
- 05 Photochemistry
- 06 Radiation Chemistry
- 07 Radiochemistry and Nuclear Chemistry
- 08 Combustion, Pyrolysis, and High-Temperature Chemistry

42 ENGINEERING
- 02 Facilities and Equipment
- 03 Lasers
- 04 Heat Transfer and Fluid Flow
- 05 Materials Testing
- 08 Electronic Circuits and Devices
- 09 Waste Processing Plants and Equipment
- 10 Combustion Systems
- 20 Underground Engineering
- 30 Marine Engineering
- 40 Pollution Control Equipment
- 50 Power Cycles

43 PARTICLE ACCELERATORS
- 01 Design, Development, and Operation
- 02 Beam Dynamics, Field Calculations, and Ion Optics
- 03 Auxiliaries and Components
- 04 Storage Rings

44 INSTRUMENTATION
- 01 Radiation Instrumentation
- 02 Radiation Effects on Instrument Components, Instruments, or Electronic Systems
- 03 Miscellaneous Instruments
- 04 Well Logging Instrumentation

45 EXPLOSIONS AND EXPLOSIVES
- 01 Chemical
- 02 Nuclear
- 03 Explosion Detection

50 ENVIRONMENTAL SCIENCES, ATMOSPHERIC
- 01 Basic Studies
- 02 Chemicals Monitoring and Transport
- 03 Radioactive Materials Monitoring and Transport
- 04 Thermal Effluents Monitoring and Transport
- 05 Site Resource and Use Studies
- 06 Regulations

51 ENVIRONMENTAL SCIENCES, TERRESTRIAL
- 01 Basic Studies
- 02 Chemicals Monitoring and Transport
- 03 Radioactive Materials Monitoring and Transport
- 04 Thermal Effluents Monitoring and Transport
- 05 Site Resource and Use Studies
- 06 Regulations

52 ENVIRONMENTAL SCIENCES, AQUATIC
- 01 Basic Studies
- 02 Chemicals Monitoring and Transport
- 03 Radioactive Materials Monitoring and Transport
- 04 Thermal Effluents Monitoring and Transport
- 05 Site Resource and Use Studies
- 06 Regulations

53 ENVIRONMENTAL—SOCIAL ASPECTS OF ENERGY TECHNOLOGIES
- 01 Social and Economic Studies
- 02 Assessment of Energy Technologies

55 BIOMEDICAL SCIENCES, BASIC STUDIES
- 01 Behavioral Biology
- 02 Biochemistry
- 03 Cytology
- 04 Genetics
- 05 Metabolism
- 06 Medicine
- 07 Microbiology
- 08 Morphology
- 09 Pathology
- 10 Physiological Systems
- 20 Public Health
- 30 Agriculture and Food Technology

56 BIOMEDICAL SCIENCES, APPLIED STUDIES
- 01 Radiation Effects
- 02 Thermal Effects
- 03 Chemicals Metabolism and Toxicology
- 04 Other Environmental Pollutant Effects

57 HEALTH AND SAFETY

58 GEOSCIENCES
- 01 Geology and Hydrology
- 02 Geophysics
- 03 Mineralogy, Petrology, and Rock Mechanics
- 04 Geochemistry
- 05 Oceanography

64 PHYSICS I
- 01 Astrophysics and Cosmology
- 02 Atmospheric Physics
- 03 Atomic, Molecular, and Chemical Physics
- 04 Fluid Physics
- 50 High Energy Physics

65 PHYSICS II
- 10 Nuclear Physics
- 12-20 Nuclear Properties and Reactions
- 30 Nuclear Theory
- 40 Radiation and Shielding Physics
- 50 Medical Physics
- 60 Condensed Matter Physics
- 61 Superconductivity
- 70 Theoretical and Mathematical Physics

70 FUSION ENERGY
- 01 Plasma Research
- 02 Fusion Power Plant Technology

99 GENERAL AND MISCELLANEOUS
- 01 Management
- 02 Mathematics and Computers
- 03 Information Handling
- 04 Law
- 05 Civilian Defense

CORPORATE AUTHOR INDEX

PERSONAL AUTHOR INDEX

SUBJECT INDEX

CONTRACT NUMBER INDEX

REPORT NUMBER INDEX

ORDER NUMBER CORRELATION

Alphabetical Listing of Categories

33 ADVANCED AUTOMOTIVE PROPULSION SYSTEMS
35 ARMS CONTROL
56 BIOMEDICAL SCIENCES, APPLIED STUDIES
55 BIOMEDICAL SCIENCES, BASIC STUDIES
40 CHEMISTRY
01 COAL AND COAL PRODUCTS
30 DIRECT ENERGY CONVERSION
20 ELECTRIC POWER ENGINEERING
32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION
29 ENERGY PLANNING AND POLICY
25 ENERGY STORAGE
42 ENGINEERING
52 ENVIRONMENTAL SCIENCES, AQUATIC
50 ENVIRONMENTAL SCIENCES, ATMOSPHERIC
51 ENVIRONMENTAL SCIENCES, TERRESTRIAL
53 ENVIRONMENTAL—SOCIAL ASPECTS OF ENERGY TECHNOLOGIES
45 EXPLOSIONS AND EXPLOSIVES
70 FUSION ENERGY
99 GENERAL AND MISCELLANEOUS
58 GEOSCIENCES
15 GEOTHERMAL ENERGY
57 HEALTH AND SAFETY
13 HYDRO ENERGY
08 HYDROGEN
44 INSTRUMENTATION
07 ISOTOPE AND RADIATION SOURCE TECHNOLOGY
36 MATERIALS
03 NATURAL GAS
05 NUCLEAR FUELS
21 NUCLEAR POWER PLANTS
22 NUCLEAR REACTOR TECHNOLOGY
04 OIL SHALES AND TAR SANDS
09 OTHER SYNTHETIC AND NATURAL FUELS
43 PARTICLE ACCELERATORS
02 PETROLEUM
64 PHYSICS I
65 PHYSICS II
14 SOLAR ENERGY
16 TIDAL AND WAVE POWER
17 WIND ENERGY

Energy Research Abstracts

01 COAL AND COAL PRODUCTS

0103 Preparation

Refer also to citation(s) 46841, 46880

46790 (DOE/PC/79881–T1) **Advanced technology for ancillary coal cleaning operations: Final report.** Manufacturing and Technology Conversion International, Inc., Santa Fe Springs, CA (USA). Nov 1988. 168p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-87PC79881. (MTCI–79881-104-F). Order Number DE89016048/JAW. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

The present program is aimed at, helping to realize the benefits that may be achieved from using competitively available clean coal as an alternative to petroleum-derived and natural gas-based fuels and/or as a substitute for costly back-end environmental control such as flue gas desulfurization. This report describes the activities undertaken by MTCI for the DOE-Pittsburgh Energy Technology Center for three different ancillary operations. Although programmatically related, the effort consisted of four separate subprojects, each at a different level of development. The first two subprojects consisted of the direct and indirect drying of beneficiated coal utilizing MTCI's proprietary pulse combustion technology. The effort was comprised of a laboratory-scale verification of the MTCI concepts for reducing the overall cost and enhancing the safety of the drying process. The third ancillary process was the reconstitution of coal fines using a continuous extrusion process to provide a safe and economic fuel that could eliminate the handling problems of micronized clean coal and/or the enhanced cost of preparation, transport, and utilization of coal slurries. The fourth ancillary process was the feasibility of utilizing a hydraulic shockwave technique for the cost-effective comminution of coal. This task was exploratory in nature and involved a literature survey on methods and techniques for producing the shock and the design and fabrication of a simple laboratory device with which to empirically explore the feasibility of hydraulic shock comminution (HSC). 20 refs., 48 figs., 18 tabs.

46791 (DOE/PETC/QTR–88/3) **[Pittsburgh Energy Technology Center] quarterly technical progress report for the period ending June 30, 1988.** USDOE Pittsburgh Energy Technology Center, PA (USA). Mar 1989. 148p. Sponsored by U.S. DOE Fossil Energy. Order Number DE89013433/JAW. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

Research programs, from the Pittsburgh Energy Technology Center are briefly described. Areas of research include: clean coal technology, coal preparation, flue gas cleanup, alternative fuels, advanced combustion, MHD program, coal liquefaction, coal science, transport and combustion, and technology transfer. 11 figs., 18 tabs. (CBS)

0104 Processing

Refer also to citation(s) 46791, 46837, 46898, 47076, 47378, 47385, 47484

46792 (BNL–42836) **Mild gasification mechanisms and char conversion.** Steinberg, M.; Fallon, P.T.; Sundaram, M.S. Brookhaven National Lab., Upton, NY (USA). Jun 1989. 15p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC02-76CH00016. (CONF-890666–3: Gasification and gas stream cleanup systems, Morgantown, WV (USA), 27-30 Jun 1989). Order Number DE90000035/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The purpose of these programs is to (1) obtain basic process chemistry data for the mild gasification of various coal types in a stirred moving bed reactor as a function of process variables and (2) construct a countercurrent moving bed reactor for obtaining data on the hydrogasification of char resulting from mild gasification. Results are described. 2 refs., 7 figs., 8 tabs.

46793 (CONF-880915–3) **Donor hydrogen depletion in coal liquefaction.** Burke, F.P.; Winschel, R.A. Consolidation Coal Co., Library, PA (USA). Research and Development Dept. [1988]. 9p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-84PC70018. From 5. annual international Pittsburgh coal conference; Pittsburgh, PA (USA); 12-16 Sep 1988. Order Number DE89017626/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A ^{1}H-NMR method is presented that provides a measurement of the loss in donor hydrogan of a solvent during coal liquefaction. The method is fast and relatively simple to perform. It relies on several assumptions that limit the scope of its application. Nevertheless, within these limitations, the method is found to give comparable results to much more complex compositional analyses. Several applications of the method to batch and continuous liquefaction experiments are presented. One of the applications presented demonstrates the relation of coal conversion with donor depletion. Another includes a discussion of the isomerization of hydroaromatics to indan-like compounds at liquefaction conditions, which reduces the donor capacity of a solvent. Last, the importance of maintaining solvent donor hydrogen to the performance of liquefaction at SRC-like conditions is demonstrated. 5 refs., 2 figs., 3 tabs.

46794 (CONF-8409210–, pp. 489-528) **Electronic structure calculations for low coverage adlayers.** Feibelman, P.J. (Sandia National Labs., Albuquerque, NM (USA)). Oak Ridge National Lab., TN (USA); Texas A and M Univ., College Station, TX (USA). Dept. of Chemistry. 1984. From Texas A and M symposium on theory, modeling and instrumentation for materials design; College Station, TX (USA); 17-19 Sep 1984. In *Theory, modeling and instrumentation for materials by design. Proceedings of workshop.* Order Number DE89007940/JAW. Available from NTIS, PC A99/MF A01.

An important direction for surface electronic structure calculations in the next few years will be the study of low coverage adsorption systems. In this presentation, the author illustrates a present-day brute-force low coverage calculation and gives an idea of an elegant and more efficient method for low coverages that is under development. The example the author uses is the methanation of carbon monoxide over nickel.

46795 (CONF-8707212–, pp. 1-10) **Introduction to workshop.** McIlwain, M. (Idaho National Engineering Lab., Idaho Falls (USA)). USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA); USDOE Idaho Operations Office, Idaho Falls, ID (USA). 1987. From Biological treatment of coals workshop; Vienna, VA (USA); 8-10 Jul 1987. In *Biological treatment of coals workshop. Proceedings.* Order Number DE89010545/JAW. Available from NTIS, PC A20/MF A01.

This overview summarizes the outcome of the second workshop on bioprocessing of coals. This overview is not intended to critically review the technical papers, but rather to review the current state-of-the-art, to identify areas that need more effort, and to present the questionnaire answers. Interested readers are encouraged to review those topics of interest and to formulate their own impression of the state-of-the-art. Topics discussed include: state of bioprocessing of coals; assessment of microbial desulfurization; assessment of microbial solubilization; assessment of microbial gasification; assessment of process economics; and questionnaire responses.

46796 (CONF-8707212–, pp. 11-23) **Introductory remarks.** Frye, K. USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA); USDOE Idaho Operations Office, Idaho Falls, ID (USA). 1987. From Biological treatment of coals workshop; Vienna, VA (USA); 8-10 Jul 1987. In *Biological treatment of coals workshop. Proceedings.* Order Number DE89010545/JAW. Available from NTIS, PC A20/MF A01.

This paper describes the activities of the Office of Fossil Energy and especially the bioprocessing of coal initiative. Information is presented on the organization of research programs on coal, oil, gas, and shale technologies. The bioprocessing initiative came out of the fundamental research activities; but research is now being done on four areas: isolation and identification of active cultures; characterization of coal structure versus microbial activity; acclimatization and improvement of organisms; and the ranking of organisms. The overall objective is to use biotechnology to desulfurize, liquefy, or gasify coal.

46797 (CONF-8707212–, pp. 24-39) **Recent progress in coal bioprocessing research in the United States.** Olson, G.J. (National Bureau of Standards, Gaithersburg, MD (USA)). USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA); USDOE Idaho Operations Office, Idaho Falls, ID (USA). 1987. From Biological treatment of coals workshop; Vienna, VA (USA); 8-10 Jul 1987. In *Biological treatment of coals workshop. Proceedings.* Order Number DE89010545/JAW. Available from NTIS, PC A20/MF A01.

Recent research on the microbiological treatment of coals is concerned with applying microorganisms to clean, upgrade, or transform coals. These research areas include: (1) coal desulfurization, including both inorganic (iron disulfides, mainly pyrite) and organic (sulfur occurring as part of the coal structure) sulfur removal; (2) coal solubilization (especially with lower rank coals by certain bacteria and fungi); (3) coal or coal product conversion to methane or organic acids; (4) removal of metals from coal. Another potential application for the microbial treatment of coals is the upgrading of coal through oxygen or nitrogen removal; however, this application has received little or no investigation. The progress in the four areas is described.

46798 (CONF-8707212–, pp. 40-72) **Recent progress in coal bioprocessing research in Europe.** Couch, G.R. (IEA Coal Research, London (England)). USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA); USDOE Idaho Operations Office, Idaho Falls, ID (USA). 1987. From Biological treatment of coals workshop; Vienna, VA (USA); 8-10 Jul 1987. In *Biological treatment of coals workshop. Proceedings.* Order Number DE89010545/JAW. Available from NTIS, PC A20/MF A01.

In connection with the work on microbial desulfurization, the European effort has concentrated on looking at practical plant designs based on kinetic reaction data obtained in the laboratory. The question of desulfurzation appears rather different from a European (and world) perspective, as compared to the situation in the US. For example, there are several countries with high sulfur, low-rank coals in which the higher proportion of the sulfur is present in organic form. While the work on pyrite removal has been well documented and has been replicated by different workers, organic sulfur removal is at a much less developed stage. In the U.K., work is going to enhance the physical separation processes currently used in coal cleaning by using microorganisms to alter the surface properties of various particles during flotation. Fundamental studies aimed at identifying organisms capable of attacking and degrading the coal molecule (particularly in the FRG) have been based on bituminous coal degradation. This contrasts with work in the US, where some success with lignites and weathered lignite in the form of leonardite has been achieved. The use of biotechnology in connection with coal bioprocessing must be looked at principally as a potential long-term development. The inherent problems associated with the nature of coal must be recognized, but research has already demonstrated possibilities that even 5 to 10 years ago would have been discounted. By using analytical techniques to examine coal degradation products, a better knowledge and understanding of coal structure may be gained.

46799 (CONF-8707212–, pp. 73-88) **A research plan for coal biogasification.** Reed, L. (Sheladia Associates, Inc., Rockville, MD (USA)). USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA); USDOE Idaho Operations Office, Idaho Falls, ID (USA). 1987. From Biological treatment of coals workshop; Vienna, VA (USA); 8-10 Jul 1987. In *Biological treatment of coals workshop. Proceedings.* Order Number DE89010545/JAW. Available from NTIS, PC A20/MF A01.

The author has developed a research plan for the biogasification of coal, based on the ability of microorganisms to serve as regenerating catalysts. An additional advantage of using microorganisms, besides process considerations, is that the catalyst can duplicate itself, using readily available materials to create a very specialized catalyst. No factors are required, nor are any rigorous conditions. The organisms can be modified through acclimation or through genetic engineering. Supplementary research in the disciplines of coal structure, gasification, bioprocess engineering, and genetic engineering can be applied to the problems of microbial coal conversion, given the correct interdisciplinary team of researchers. One other aspect to consider in the development of coal biogasification processes is the implication of existing and future regulatory policies. These policies have not yet been confirmed, but are currently intended as recommendations. However, by the time coal biogasification processes are developed to the commercial level, the regulations may be established. A knowledge of regulatory policy must accompany all of this research. One must also consider how workers in this field can affect the regulatory process, so that work under design today can be compatible with the environment of tomorrow.

46800 (CONF-8707212–, pp. 89-118) **Biological conversion of synthesis gas into liquid fuels.** Clausen, E.C. (Univ. of Arkansas, Fayetteville (USA)); Gaddy, J.L. USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA); USDOE Idaho Operations Office, Idaho Falls, ID (USA). 1987. DOE Contract AC05-84OR21400. From Biological treatment of coals workshop; Vienna, VA (USA); 8-10 Jul 1987. In *Biological treatment of coals workshop. Proceedings.* Order Number DE89010545/JAW. Available from NTIS, PC A20/MF A01.

A culture has been isolated from natural inocula that is capable of producing ethanol and acetate from CO in synthesis gas. The culture requires only low levels of yeast extract for growth, and product formation is greatly enhanced by agitation. A pure culture has been isolated and preliminary observations indicate that the culture belongs to the Clostridium species.

46801 (CONF-8707212–, pp. 119-136) **Depolymerization of low-rank coals by a unique microbial consortium.** Wyza, R.E. (Atlantic Research Corp., Alexandria, VA (USA)); Desourza, A.E.; isbister, J.D. USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA); USDOE Idaho Operations Office, Idaho Falls, ID (USA). 1987. From Biological treatment of coals workshop; Vienna, VA (USA); 8-10 Jul 1987. In *Biological treatment of coals workshop. Proceedings.* Order Number DE89010545/JAW. Available from NTIS, PC A20/MF A01.

Atlantic Research Corporation has isolated a mixture of fungi and bacteria (CP1+2) capable of relatively rapid and extensive depolymerization of low-rank coals. This consortium solubilizes untreated Leonardite as well as several mildly pretreated (4-8N HNO_3 for 1 hour) lignites and a Wyodak subbituminous coal. Growth of the consortium in full-strength Trypticase Soy Broth (TSB) results in the greatest depolymerization activity. The active system is produced in the presence or absence of coal. At least 50% of the activity is found extracellularly. Activity in refrigerated whole cultures decreases rapidly after a relatively long, stable period (2-3 weeks), while refrigerated cell-free culture filtrates maintain activity for several months. Depolymerization activity is destroyed by heating, suggesting that the process may be partially enzymatic. The optimum pH for coal depolymerization is approximately 8.7, at or near the natural pH of the growing culture. Activity is negligible at pH >7. Above this pH, nonmicrobial coal solubilization increases gradually, while microbial solubilization increases rapidly. The solubilized product of coal depolymerization is a dark brown material which is coal-like in appearance after lyophilization. Ultraviolet scans of the product do not exhibit any characteristic peaks, indicating that many molecular species are present. Initial attempts have been made to separate and characterize the depolymerized products by using size-exclusion chromatography and GC/MS. The microbially solubilized product of Leonardite appears to be composed of small molecules (MW < 1800). In contrast, the microbially solubilized product of Beulah lignite appears to have a broader size range.

46802 (CONF-8707212–, pp. 137-150) **Partial degradation of untreated, hard coal by microorganisms.** Fakoussa, R.M.

(Rheinische Friedrich-Wilhelms-Universitat, Bonn (West Germany)). USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA); USDOE Idaho Operations Office, Idaho Falls, ID (USA). 1987. From Biological treatment of coals workshop; Vienna, VA (USA); 8-10 Jul 1987. In *Biological treatment of coals workshop. Proceedings.* Order Number DE89010545/JAW. Available from NTIS, PC A20/MF A01.

Finely ground coal is partially degraded aerobically by both fungi and bacteria. Fungal breakdown involves extracellular enzymes bound to the cell wall, whereas bacteria utilize only leached components from the coal. Other bacteria appear to excrete free extracellular proteins that may have some catalytic activity, and which adsorb to the coal particles. This is illustrated by the release of brown colored compounds from the coal into the culture supernatant. The coal particles become more hydrophobic and the infrared spectrum shows a decrease in the aromatic fraction. The extractability of the coal is simultaneously changed in comparison to the non-biologically treated coal. These results show that hard coal is not microbiologically inert.

46803 (CONF-8707212–, pp. 151-173) **Comparison of alkali and microbial solubilization of oxidized, low-rank coal.** Quigley, D.R. (Idaho National Engineering Labs., Idaho Falls (USA)); Wey, J.E.; Breckenridge, C.R.; Hatcher, H.J. USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA); USDOE Idaho Operations Office, Idaho Falls, ID (USA). 1987. DOE Contract AC07-76ID01570. From Biological treatment of coals workshop; Vienna, VA (USA); 8-10 Jul 1987. In *Biological treatment of coals workshop. Proceedings.* Order Number DE89010545/JAW. Available from NTIS, PC A20/MF A01.

Work in this laboratory has involved studying the effects of nitric acid treatment on Texas lignite and how this pretreatment enhances microbial coal solubilization. Treatment of Texas lignite with 8N (35%) nitric acid for one hour (TXL-35S) resulted in a 35-40% loss of material. An FTIR spectrum of the original Texas lignite was obtained and subtracted from that obtained for TXL-35S. A strong absorbance band at 1700 cm^{-1} indicated that a significant amount of oxidation had taken place. Absorption bands at 1540 and 1340 cm^{-1} indicated that this treatment also resulted in coal nitration. Solubilization of TXL-35S was tested using six microorganisms. Solubilization of TXL-35S was accomplished by the six microorganisms without any detectable changes in FTIR spectra. UV-Vis spectral changes of solubilized TXL-14S were present in culture fluids of S. viridosporous and S. flavovirens, while cultures of RWL-5 did not appear to solubilize coal. In all cases except for S. viridosporus, solubilization of TXL-14S occurred with a simultaneous increase in culture fluid pH. Subsequent experiments indicated that 50% of TXL-35S was alkali soluble, 35% was volatile, and 15% was alkali insoluble. Finally, UV-Vis spectra of solubilized coal were altered by cultures of S. flavovirens and RWL-5, while FTIR spectra were changed only in cultures of RWL-5. Taken together, these data suggest that a mechanism of microbial coal solubilization of nitric acid oxidized coal involves the production of materials that increase pH. Subsequent reactions with solubilized coal may then occur in cultures of RWL-5, S. flavovirens and, possibly, S. viridosporus.

46804 (CONF-8707212–, pp. 174-194) **Enzymatic degradation of low-rank coals by a cell-free enzymatic system from coriolus versicolor.** Pyne, J.W. (Battelle Pacific Northwest Labs., Richland, WA (USA)); Stewart, D.L.; Linehan, J.C.; Bean, R.M.; Powell, M.A.; Lucke, R.B.; Thomas, B.L.; Campbell, J.A.; Wilson, B.W. USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA); USDOE Idaho Operations Office, Idaho Falls, ID (USA). 1987. From Biological treatment of coals workshop; Vienna, VA (USA); 8-10 Jul 1987. In *Biological treatment of coals workshop. Proceedings.* Order Number DE89010545/JAW. Available from NTIS, PC A20/MF A01.

An extracellular fraction from the lignin degrading white-rot fungus, Coriolus versicolor, can biosolubilize leonardite and pretreated lignites in vitro. Leonardite is often found as an overburden to lignite deposits, and is related to humic acid, and is more oxidized than lignites. Extracts from certain fungi such as C. versicolor solubilize leonardite. The biosolubilization activity is at least in part enzymatic in nature. A protein which is at least partly responsible for the solubilization effect has been substantially purified and concentrated by ultrafiltration and ion-exchange chromatography from the broth of an agitated submerged culture of C. versicolor grown in a defined medium. An in vitro coal biosolubilization assay was used to establish the effects of various physical and chemical factors affecting enzyme activity, including temperature and the salt and buffer composition of the reaction mixture. Some initial studies on the mechanism of the enzymatic leonardite biosolubilization reaction are described.

46805 (CONF-8707212–, pp. 195-212) **Microbial solubilization of peat for production of synthetic fuels.** Gunasekaran, M. (Fisk Univ., Nashville, TN (USA)). USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA); USDOE Idaho Operations Office, Idaho Falls, ID (USA). 1987. DOE Contract FG22-85PC80538. From Biological treatment of coals workshop; Vienna, VA (USA); 8-10 Jul 1987. In *Biological treatment of coals workshop. Proceedings.* Order Number DE89010545/JAW. Available from NTIS, PC A20/MF A01.

Peat is a partially decomposed plant material rich in organic substances and lignocelluoses. It serves as a potential substrate for various fermentations such as the production of important industrial chemicals - alcohols, sugars, organic acids, and single cell proteins. The objective is to evaluate the potential of microbes to hydrolyze and liquify the peat for the production of synthetic fuels. The author reports here on the use of peat as a substrate for the growth of the white rot fungus Phanerochaete chrysosporium and on the production of hydrolytic enzymes responsible for the cleavage of sugars such as cellulase, xylanase, and cellobiose.

46806 (CONF-8707212–, pp. 213-230) **Biological solubilization of coal in aqueous and nonaqueous media.** Scott, C.D. (Oak Ridge National Lab., TN (USA)); Faison, B.D. USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA); USDOE Idaho Operations Office, Idaho Falls, ID (USA). 1987. DOE Contract AC05-84OR21400. From Biological treatment of coals workshop; Vienna, VA (USA); 8-10 Jul 1987. In *Biological treatment of coals workshop. Proceedings.* Order Number DE89010545/JAW. Available from NTIS, PC A20/MF A01.

Several research groups have shown that low-ranked coals can be solubilized by many different fungi and a few bacteria. This type of bioconversion process has been carried out in an aqueous, aerobic environment (suspension culture or humid air) to yield a product that is water soluble and of relatively high molecular weight. Many of these organisms have previously been shown to be highly lignolytic. Additional tests are being made to investigate other ligninolytic microorganisms, such as Phanerochaete chrysosporium; and to optimize the experimental parameters for the microbial solubilization process. Some of the earlier tests indicated that the microbial solubilization of coal is predominantly an extracellular process. Therefore, solubilization processes can also be considered in which appropriate enzymes are used in vitro. For such concepts, both aerobic and anaerobic systems are being studied with either an aqueous or organic solvent. The products resulting from anaerobic interactions have properties that are significantly different from those of the products of aerobic solubilization by microorganisms.

46807 (CONF-8707212–, pp. 231-241) **Slurry concentration and mesh size in the development of microbial coal desulfurization.** Harsh, D. (Coal Biotech Corp., Libertyville, IL (USA)); Dybel, M.; Skidmore, D. USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA); USDOE Idaho Operations Office, Idaho Falls, ID (USA). 1987. From Biological treatment of coals workshop; Vienna, VA (USA); 8-10 Jul 1987. In *Biological treatment of coals workshop. Proceedings.* Order Number DE89010545/JAW. Available from NTIS, PC A20/MF A01.

The microbial coal desulfurization technology developed for Sulfolobus acidocaldarius, a thermophilic archeobacterium, has been found to require additional reaction time with a high slurry concentration and a coarse coal feed. The rates and extent of coal desulfurization for two North American coals was measured in duplicate in the laboratory at a concentration range of 5% to 45% by weight in water, and a size range of from 75% less than 74 microns to 8-20 microns. The range of average residence times extended from two to fourteen days in feed batch operation. Results indicated extremely rapid sulfur removal. The fed batch mode reduced or eliminated lag times associated with batch operation and inoculated

the feed coal rapidly by natural cell reproduction. Economic analysis showed that intermediate values of coal size reduction (90% minus 75 microns), and slurry concentration (20%-25% by weight) were preferred for a midwestern US site.

46808 (CONF-8707212–, pp. 242-277) **Bacterial desulfurization of Turkish lignites.** Yurteri, R. (Middle East Technical Univ., Ankara (Turkey)); Gokcay, C.F. USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA); USDOE Idaho Operations Office, Idaho Falls, ID (USA). 1987. From Biological treatment of coals workshop; Vienna, VA (USA); 8-10 Jul 1987. In *Biological treatment of coals workshop. Proceedings.* Order Number DE89010545/JAW. Available from NTIS, PC A20/MF A01.

In this study the applicability of bacterial coal desulfurization to Turkish lignites and Nallihan-Cayirhan lignites, in particular, was investigated in shake-flask culture systems. The effect of various parameters on the efficiency of desulfurization by Thiobacillus ferrooxidans was tested. A Thiobacillus related mixotroph was found to remove some of the organics as well.

46809 (CONF-8707212–, pp. 278-294) **Microbial degradation of organosulfur compounds: implications for the microbial desulfurization of coal.** Stoner, D.L. (Idaho National Engineering Lab., Idaho Falls (USA)). USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA); USDOE Idaho Operations Office, Idaho Falls, ID (USA). 1987. DOE Contract AC07-76ID01570. From Biological treatment of coals workshop; Vienna, VA (USA); 8-10 Jul 1987. In *Biological treatment of coals workshop. Proceedings.* Order Number DE89010545/JAW. Available from NTIS, PC A20/MF A01.

Metabolic pathways for the degradation of dibenzothiophene (DBT) may provide insight into possible mechanisms for the microbial removal of organically bound sulfur from coal. Desired degradation pathways would involve a direct attack from the thiophene ring and would result in the formation of sulfate and either biphenyl or 2, 2 dihydroxybiphenyl. A similar attack upon thiophenic rings in coal could conceivably eliminate this sulfur form from the coal matrix. Enrichment cultures of coal that had been pre-treated with Thiobacillus ferrooxidans were used as a substrate to obtain microorganisms with possible activity towards the organic sulfur component of coal. Results indicated that the sulfate released by the majority of active cultures was probably due to the acid leaching of sulfate sulfur in water washed T. ferrooxidans pre-treated coal and was not due to the degradation of organic sulfur compounds.

46810 (CONF-8707212–, pp. 295-325) **Desulfurization of coal by bacterial means.** Chandra, D. (Indian School of Mines, Dhanbad); Misra, A.K. USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA); USDOE Idaho Operations Office, Idaho Falls, ID (USA). 1987. From Biological treatment of coals workshop; Vienna, VA (USA); 8-10 Jul 1987. In *Biological treatment of coals workshop. Proceedings.* Order Number DE89010545/JAW. Available from NTIS, PC A20/MF A01.

There is a substantial deposit of coal in Assam, India. These coals are of good quality, particularly because of their low ash content combined with their good coking character. Despite this, these coals are generally not used because of a high total sulfur content. The problem with using these coals has become more acute because in addition to pyritic and sulfate sulfur, these coals contain a high proportion of organic sulfur. This form of sulfur is very difficult to remove by present commercial technology. The purpose of the present investigation was to remove sulfur from Assam coals by bacterial means under controlled laboratory conditions.

46811 (CONF-8707212–, pp. 347-366) **Microbial desulfurization of coal: A feasible process?.** Bos, P. (Delft Univ. of Technology (Netherlands)); Huber, T.F.; Luyben, K.C.A.M.; Kuenen, J.G. USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA); USDOE Idaho Operations Office, Idaho Falls, ID (USA). 1987. From Biological treatment of coals workshop; Vienna, VA (USA); 8-10 Jul 1987. In *Biological treatment of coals workshop. Proceedings.* Order Number DE89010545/JAW. Available from NTIS, PC A20/MF A01.

One of the Dutch coal research programs focuses on the technical and economical feasibility of different coal cleaning techniques: High Gradient Magnetic Separation (HGMS), Electrostatic Separation (ESS), and microbial desulfurization of coal. The aim of this program is to collect data to enable the Dutch Government to compare these three processes, which are aimed especially at the removal of inorganic sulfur compounds from coals. The biological cleaning technique is based on the ability of some acidophilic bacteria, of which Thiobacillus ferrooxidans is the best known, to oxidize sulfidic minerals, especially pyrite, which is the most important sulfur compounds in coal. Coal can be desulfurized in two different ways. In the more popular method, the bacteria oxidize as much as the inorganic sulfur compounds in the coal as possible (the complete oxidation process). In the other method, bacteria are used only initially to change the surface properties of the pyrite particles by using physical separation techniques such as oil agglomeration and flotation to remove pyrite from the coal. This paper discusses the results of applied microbiological studies, kinetic studies, and studies on oxygen mass transfer, mixing, and sedimentation in Pachuca-tank reactors. A cost estimation is also described.

46812 (CONF-8707212–, pp. 367-388) **A comparison between Thiobacillus ferrooxidans and biological by-products in the desulfurization of coal fines in flotation.** Davis, A.J. (North Staffordshire Polytechnic (England)); Atkins, A.S. USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA); USDOE Idaho Operations Office, Idaho Falls, ID (USA). 1987. From Biological treatment of coals workshop; Vienna, VA (USA); 8-10 Jul 1987. In *Biological treatment of coals workshop. Proceedings.* Order Number DE89010545/JAW. Available from NTIS, PC A20/MF A01.

Any process that can remove sulfur prior to combustion by conventional coal preparation techniques is worthy of consideration in efforts to reduce the effects of acid rain. This paper compares an existing bio-flotation technique using Thiobacillus ferrooxidans with a much simpler one involving the use of various biological by-products. The mechanism behind the process is the same in both systems: the pyritic sulfur in the coal fines is rendered hydrophilic and then it is separated by conventional froth flotation. The development of the Thiobacillus ferrooxidans system into a commercial process is constrained by the time required to produce large quantities of active cells. The advent of the biological by-products has removed this constraint and allowed full development of the system. This paper quantifies the pyritic suppression effects in both systems in terms of pyrite flotation and coal feeds, and thereby allows a direct comparison of the two systems. Zeta potential measurements of the surface effects are also discussed in order to establish the optimum dosage of reagent for both experimental and scale-up purposes.

46813 (CONF-8707212–, pp. 389-424) **Pyrite decomposition and structural alteration of hard coal due to microbe-assisted pyrite removal.** Beier, E. (Westfaelische Berggewerkschaftskasse, Bochum (West Germany)). USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA); USDOE Idaho Operations Office, Idaho Falls, ID (USA). 1987. From Biological treatment of coals workshop; Vienna, VA (USA); 8-10 Jul 1987. In *Biological treatment of coals workshop. Proceedings.* Order Number DE89010545/JAW. Available from NTIS, PC A20/MF A01.

Thiobacilli may either attack the pyrite-containing coal directly, or contribute to its oxidation by catalyzing the oxidation of bivalent ferric salts through oxygen that is dissolved in water. The importance of both of the above mechanisms during pyrite removal from hard-coals is discussed. This is followed by a review of experiments meant to identify the influence of coal rank, grain size, pyrite genesis, and content on the pyrite removal efficiency to be attained within a given period of time. The paper furthermore reports on experiments meant to examine the seepage rate of the biopulp in coal heaps. Investigations into the alteration of coal properties due to pyrite removal are dealt with as well. In conclusion, plant dimensions and pyrite removal for two plant designs are presented.

46814 (DOE/ER/13616–3) **[Free radical and rearrangement reactions in coal liquefaction].** Indiana Univ., Bloomington, IN (USA). [1989]. 20p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER13616. Order Number DE89017423/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Progress has been made in understanding high temperature tetralin chemistry and in development of molecular mechanics approaches to radicals and organometallic compounds. This continuation proposal focuses on continued pursuit of the kinetics as a

function of pressure, on study of the putative 1,6-biradical resulting from C-1,C-2 bond cleavage in tetralin, and on continued development of force field parameters for organometallic compounds. 16 refs.

46815 (DOE/MC/22137–2704-Vol.1) **Computational fluid dynamics assessment: Volume 1, Computer simulations of the METC [Morgantown Energy Technology Center] entrained-flow gasifier: Final report.** Celik, I.; Chattree, M. West Virginia Univ., Morgantown, WV (USA). Dept. of Mechanical and Aerospace Engineering. Jul 1988. 398p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-85MC22137. Order Number DE89000990/JAW. Available from NTIS, PC A17/MF A01 - OSTI; GPO Dep.

An assessment of the theoretical and numerical aspects of the computer code, PCGC-2, is made; and the results of the application of this code to the Morgantown Energy Technology Center (METC) advanced gasification facility entrained-flow reactor, "the gasifier," are presented. PCGC-2 is a code suitable for simulating pulverized coal combustion or gasification under axisymmetric (two-dimensional) flow conditions. The governing equations for the gas and particulate phase have been reviewed. The numerical procedure and the related programming difficulties have been elucidated. A single-particle model similar to the one used in PCGC-2 has been developed, programmed, and applied to some simple situations in order to gain insight to the physics of coal particle heat-up, devolatilization, and char oxidation processes. PCGC-2 was applied to the METC entrained-flow gasifier to study numerically the flash pyrolysis of coal, and gasification of coal with steam or carbon dioxide. The results from the simulations are compared with measurements. The gas and particle residence times, particle temperature, and mass component history were also calculated and the results were analyzed. The results provide useful information for understanding the fundamentals of coal gasification and for assessment of experimental results performed using the reactor considered. 69 refs., 35 figs., 23 tabs.

46816 (DOE/MC/23277–2731) **Phase I, Volume I, Program summary and PDU [process development unit] operations: Topical report, October 1987–January 1989.** Robin, A.M.; Wu, C.M.; Kassman, J.S. Texaco, Inc., Montebello, CA (USA). Montebello Research Lab. Mar 1989. 216p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC21-87MC23277. Order Number DE89011675/JAW. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

The work described in this report (Volume I of a three volume set) was primarily done at Texaco's Montebello Research Laboratory, located near Los Angeles, California. It covers the first year of a five year program designed to demonstrate the integration of high temperature desulfurization with the Texaco Coal Gasification Process. Supporting work at MIT and at the Texaco Research Center in Beacon, New York is also briefly described. Theoretical studies and bench scale tests were done to identify in-situ and external high temperature desulfurization sorbents suitable for use with the Texaco Coal Gasification Process. For in-situ desulfurization, only iron oxide and the iron oxide/sodium oxide system had potential for success. PDU tests were made with iron oxide and iron oxide/sodium oxide in-situ sulfur sorbents. The results showed that 50–60% of the sulfur in the synthesis gas could be captured with either system, but the iron oxide/sodium oxide system produced extremely small solid particles which rendered the system inoperable. External sorbents tested in the PDU included zinc ferrite, zinc copper ferrite and zinc titanate. Of these, only the zinc titanate was found to be suitable. 34 figs., 26 tabs.

46817 (DOE/MC/23288–2697) **Steam conditioning of coal for synfuels production: Final report.** Graff, R.A.; Zhou, P.; Brandes, S.D. City Coll., New York, NY (USA). Nov 1988. 89p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-87MC23288. Order Number DE89000987/JAW. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

Conditioning of coal in steam was explored as a means of improving the yield and quality of condensable product obtainable in the mild gasification of coal. The possibility of lowering the pressure needed for steam conditioning was examined. Yields of conditioning volatiles and yields of pyridine extract from conditioned Illinois No. 6 coal, at conditioning temperatures from 500 to 760°F and pressures from one to fifty atm, show that steam conditioning is successful at the lower pressures as well. An important new steam conditioning regime at atmospheric pressure has been tentatively identified with a maximum at about 570°F (300°C) where the yield of extract plus volatiles is one-third greater than that for raw coal. The yields of volatiles released during conditioning of Mississippi lignite in steam and in helium were determined in the temperature range 500 to 750°F at atmospheric pressure and at 50 atm. The yields were surprisingly high. Pyridine extractions of Mississippi lignite were conducted on samples conditioned in steam at 1 and 50 atm. For comparison, extraction yields were also determined for samples conditioned in helium. A fluidized bed steam mild gasification test facility has been designed, constructed, and put into operation. Mild gasification runs were made using both raw and steam conditioned Illinois No. 6 coal. At 1026°F the yield of condensable product from conditioned coal is raised to 37.4 wt % daf, 15% (relative) higher than for raw coal (conditioning volatiles not included). Moreover, the molecular weight is reduced 31%. 9 refs., 33 figs., 19 tabs.

46818 (DOE/PC/70018–68) **Coal liquefaction process solvent characterization and evaluation: Technical progress report, July 1–September 30, 1988.** Winschel, R.A.; Robbins, G.A.; Burke, F.P. Consolidation Coal Co., Library, PA (USA). Research and Development Dept. Jul 1989. 92p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-84PC70018. Order Number DE89016731/JAW. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

Consolidation Coal Research and Development is characterizing samples of direct coal liquefaction process oils based on a variety of analytical techniques to provide a detailed description of the chemical composition of the oils, to more fully understand the interrelationship of process oil composition and process operations, to aid in plant operation, and to lead to process improvements. The approach taken is to obtain analyses of a large number of well-defined process oils taken during periods of known operating conditions and known process performance. 10 refs., 18 figs., 30 tabs.

46819 (DOE/PC/80908–12) **Low severity coal conversion by ionic hydrogenation: Progress report, May–July 1989.** Maiorello, J.; Larsen, J.W. Lehigh Univ., Bethlehem, PA (USA). Dept. of Chemistry. 3 Aug 1989. 9p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-85PC80908. Order Number DE89016756/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Objectives of this project are: (1) to explore the ionic hydrogenation of low rank coals using H_2O:BF_3 as the acid and hydrogen gas as the hydride donor in the presence of catalytic quantities of transition metal complexes to activate hydrogen, and (2) to develop the optimum reaction conditions. This quarter, since we found BF_3:H_2O may cause the polymerization of the pyridine soluble portion of Wyodak, we considered using several organic acids in conjunction with Et_3SiH as the hydrogenating pair in the ionic hydrogenation of the THF soluble portions of two coals, Bruceton and ion-exchanged Wyodak. Et_3SiH was found to co-exist in solution with TsOH:H_2O and CH_3SO_3H. Consequently these acids along with CF_3CO_2H were used as proton sources in the reactions discussed. THF was used to extract the coals since this solvent is less basic than pyridine and compatible with the chosen acids. The first series of ionic hydrogenation reactions were conducted in THF as solvent. The second series of reactions were run in either the liquid acid or Et_3SiH as solvent. 4 refs., 4 tabs.

46820 (DOE/PC/80910–T6) **A study of depolymerization and crosslinking reactions in coal liquefaction: Final report.** Solomon, P.R.; Deshpande, G.V.; Serio, M.A.; Kroo, E. Advanced Fuel Research, Inc., East Hartford, CT (USA). Jul 1989. 146p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-85PC80910. Order Number DE89015994/JAW. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

The goal of this program was to characterize the depolymerization and crosslinking reactivity of low rank coals and determine how they can be optimized in liquefaction by combining high heating rates with solvent interactions. The program had the following components: an investigation of the benefits of using solvents to stabilize depolymerization fragments formed at high heating rates. The use of coals and model polymers in a set of experiments to identify the bond breaking and crosslinking rates and mechanisms.

The use of the data in an expanded Monte Carlo model of depolymerization and crosslinking reactions to simulate the results of the above tasks, resulting in a model to aid process design. The results of the program are reported. 62 refs., 60 figs., 8 tabs.

46821 (DOE/PC/88818–2) **Two-stage, close coupled catalytic liquefaction of coal: Second quarterly report, January 1, 1989–March 31, 1989.** Comolli, A.G.; Johanson, E.S. Hydrocarbon Research, Inc., Lawrenceville, NJ (USA). Apr 1989. 21p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-88PC88818. Order Number DE89017801/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report includes data from the first bench-scale run of the program on Black Thunder Wyoming Coal and microautoclave screening studies on various coal feedstocks. Also included is an initial update of coal liquefaction economics from a 1984 to a 1988 basis. 9 figs., 4 tabs.

46822 (DOE/PC/90529–10) **Micropore diffusion in coal chars under reactive conditions: Quarterly technical progress report, 15 December 1988–15 March 1989.** Perkins, M.T.; Calo, J.M.; Lilly, W.D. Brown Univ., Providence, RI (USA). Div. of Engineering. 1989. 17p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-86PC90529. Order Number DE89017519/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The current project is concerned with the development and application of a new technique to measure micropore diffusion under actual gasification conditions. The method is an outgrowth of and related to the transient kinetics approach to the measurement of kinetic rate parameters for char-gas reactions that has been developed in our laboratory. During this reporting period: two new methods – integral and differential "difference" techniques – have been developed to analyze the diffusion data obtained from the "gradientless" reactor; and some micropore diffusion data obtained for CO_2 in PSOC-833 coal char have been interpreted using the integral technique. 2 refs., 8 figs.

46823 (EPRI-GS–6485) **Eighth annual EPRI conference on coal gasification.** Electric Power Research Inst., Palo Alto, CA (USA). c Aug 1989. 397p. Sponsored by Electric Power Research Institute. (CONF-8810105–: 8. annual EPRI conference on coal gasification, Palo Alto, CA (USA), 19-20 Oct 1988). Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report contains the technical papers presented at the Eighth Annual EPRI Conference on Coal Gasification. The four sessions covered economic and engineering studies, demonstration plant reports, new GCC concepts and development studies, and environmental and support studies. The following topics were discussed: Dow-based integrated gasification-combined-cycle study for low rank coal; a coal gasification combined cycle availability analysis; review of potential cycle improvements for and integrated coal gasification-combined-cycle plant; coproduction of electricity and methanol; operating feedstock flexibility for Texaco gasification plants; cool water plant reliability and efficiency improvements achieved during four years of operation; the Dow Syngas Project recent operating experience; status of the Shell coal gasification demonstration plant; recent developments in the demonstration of the BGL gasifier; the High-Temperature Winkler process – operational experience and new developments; four-year operating experience with Texaco Coal Gasification Process in Ube Ammonia; PRENFLO coal gasification – tests with Pittsburgh No. 8 coal; Lurgi's CFB gasification technology for combined cycle power generation (Part I) and gas production from biomass (Part II); update on Department of Energy hot gas cleanup programs; development status of hot gas clean-up technology for IGCC systems; process development of in-situ catalytic desulfurizing fluidized bed gasification for combined power and SNG manufacture; key technologies in Japan's entrained-flow HYCOL gasifier; cool water environmental performance utilizing four coal feedstocks; environmental monitoring at Dow's coal gasification plant; the BGL Gasifier: recent environmental results; and production of synthetic lightweight aggregate using cool water slag. Individual projects are processed separately for the data bases.

46824 (ORNL/Sub–86-95901/01) **A review on the effects of microalloying, surface treatment and oxidation conditions on the formation and breakdown of protective oxide scales on fossil energy materials.** Srinivasan, V. Universal Energy Systems, Inc., Dayton, OH (USA). Mar 1989. 76p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. Order Number DE89017456/JAW. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This article reviews our understanding of the effects of reactive elements and dispersoids on the oxidation and mixed gas corrosion of high temperature alloys and coatings. Reactive elements and dispersoids have profound influence on the scale adhesion and oxidation resistance of alloys. They are added in minor quantities. For application to fossil energy materials, understanding of the effects of minor alloying additions on mixed gas corrosion is required at temperatures below 700°C. Three methods of scale breakdown process are identified. Scale breakdown by the formation of base metal sulfides may start at the scale surface or below the scale at the metal/scale interface. Both of them require transport of S or base metal ions across the scale. The events that precede the initiation of scale breakdown process are not clear. The scale morphology, chemistry, phases and other microstructural features may play a major role in the breakdown process, and this role is not clear. Scale breakdown may also occur in the case of brittle α- Al_2O_3 by gas permeation through physical defects. It is also possible that the formation of α-Al_2O_3 at temperatures below 700°C in a reasonable time may be difficult. The review recommends careful study on the formation and breakdown of protective oxide scales on model alloys in multioxidants, and characterization of these processes with a variety of advanced surface analytical techniques to understand the influence of microalloying, surface and oxidation conditions. 51 refs., 32 figs., 6 tabs.

46825 Cost-effective sulfur control strategies for the Great Plains gasification project. Doctor, R.D. (Argonne National Lab., IL (USA). Energy and Environmental Systems Div.); Wilzbach, K.E. pp. 112 of Technical economics, synfuels, and coal energy. 1989. Dicks, J.B. American Society of Mechanical Engineers, New York, NY (1989). (CONF-8901108–: Technical economics, synfuels, and coal energy, Houston, TX (USA), 22-25 Jan 1989).

The Great Plains Gasification plant in Beulah, North Dakota, uses 14 Lurgi gasifiers tio produce 152 x 10^6 scf/d (4.1 x 10^6 Nm^3d) of pipeline-quality gas from lignite. Since start-up in mid-1984, the plant has provided a serious challenge to the reliable operation of the Stretford sulfur recovery system. To address this challenge, over forty options for mitigating sulfur emissions were evaluated on an economic and technical basis, beginning at the emissions source (the stack) and working back through the plant. Although this study was directed toward providing a timely solution to the sulfur dioxide emissions problem, the status and opportunities for a number of emerging technologies were brought into focus.

46826 Characterization, processing, and diesel engine evaluation of coal liquid fuels. Ryan, T.W. III (Southwest Research Institute, San Antonio, TX (US)); Likos, W.E.; Moulton, D.S.; Bauer, H.F. pp. 74 of Coal-fueled diesel engines. McMillan, M.H. Webb, H.A American Society of Mechanical Engineers, New York, NY (1989). (CONF-8901106–: Coal fueled diesel engines, Houston, TX (USA), 22-25 Jan 1989).

For this study, six different liquid materials produced from coal were evaluated for potential use as fuels for diesel engines. The liquids include of two different liquids produced during the mild gasification of coal using the United Coal Company process. Two additional materials were obtained from the Great Plains Coal Gasification Plant. One was a coal tar material, and the other was the naphtha fraction of the coal tar. The fifth liquid was a Lurgi/Ruhrgas light oil, and the sixth was a pyrolysis liquid produced in a coal coking operation. All the liquids were characterized in terms of the ASTM specifications for diesel fuel. The process liquids were blended at 30 percent by volume with diesel fuel and evaluated in a direct-injection, variable-compression ratio diesel engine. The processing requirements and the engine combustion and performance data were used to rate the quality of each of the liquids.

46827 Erosion-corrosion of materials by coal-water slurries. Levy, A.V. (Lawrence Berkeley Lab., Univ. of California, Berkeley, CA (US)); MacAdam, S. pp. 264 of Materials for coal gasification. Sklizkov, G.V American Society for Metals, Metals Park, OH (1987).

(CONF-871059–: Materials for coal gasification, Cincinnati, OH (USA), 10-15 Oct 1987).

Pulverized coal can be carried into coal gasifiers in a water slurry. The carbon steel pipes used to contain the slurry are subjected to erosion-corrosion. The potential use of erosion resistant liner materials to prevent an unacceptable metal loss rate of the carbon steel was investigated by determining the room and elevated temperature erosion rates of mild steel and a number of protective layer materials. The tests were carried out in a slurry pot tester using neutral and acidic waters for test durations that caused steady state material loss rates to occur.

46828 **Alloy and coating development for coal gasification applications.** Natesan, K. (Materials and Components Technology Div., Argonne National Lab., Argonne, IL (US)). pp. 264 of Materials for coal gasification. Sklizkov, G.V American Society for Metals, Metals Park, OH (1987). (CONF-871059–: Materials for coal gasification, Cincinnati, OH (USA), 10-15 Oct 1987).

Over the years, three major avenues have been followed to improve the sulfur resistance of metallic materials. The first approach involves modification of bulk alloy composition such as increases in chromium and/or aluminum content; additions of refractory metals such as Zr, Nb, and Ti; and additions of microalloy constituents including rare earth earth elements. The second approach involves modification of the surface region of engineering alloys via procedures such as ion implantation, sputtering of selected elements accompanied by ion beam mixing, etc. This approach can create a nonequilibrium alloy chemistry and microstructures that can impede the transport of reactants from the gas phase and cations from the alloy substrate. The third method involves coating of alloy surfaces with corrosion-resistant materials via techniques such as pack cementation, low-pressure plasma spray, and electrospark deposition. The present paper discusses several of these approaches and provides corrosion rate and scale morphology information obtained at Argonne National Laboratory.

46829 **Materials performance in coal gasification pilot plants.** Judkins, R.R. (Oak Ridge National Lab., Oak Ridge, TN (US)); Bradley, R.A. pp. 264 of Materials for coal gasification. Sklizkov, G.V American Society for Metals, Metals Park, OH (1987). (CONF-871059–: Materials for coal gasification, Cincinnati, OH (USA), 10-15 Oct 1987).

This paper presents the results of several materials testing projects which were sponsored by the U.S. Department of Energy (DOE) and conducted in operating coal gasification pilot plants in the United States. These projects were designed to test potential materials of construction for commercial plants under actual operating conditions. These materials test projects were initiated in 1974 and included in the overall test program included the Hygas, Conoco Coal, Synthane, Bi-Gas, Peatgas (Bygas operating with peat), Battelle, U-Gas, Westinghouse (now KRW), General Electric (Gegas), and Mountain Fuel Resources plants. Much of the DOE-funded activity was conducted as part of Phase Group II, Subcommittee 9 of the Metal Properties Council, Inc.

46830 **A review of failure analysis experience on coal-gasification pilot plant components.** Diercks, D.R. (Argonne National Lab., Materials and Components Technology Div., Argonne, IL (US)). pp. 264 of Materials for coal gasification. Sklizkov, G.V American Society for Metals, Metals Park, OH (1987). (CONF-871059–: Materials for coal gasification, Cincinnati, OH (USA), 10-15 Oct 1987).

During the past 15 years or so, more than 30 coal-gasification process demonstration units (PDUs) and pilot plants have been constructed and operated to develop, evaluate, and optimize candidate coal-gasification processes. A secondary benefit from the operation of these plants has been the experience and knowledge gained about materials performance and component reliability to gasifier environments. This paper reviews the failure analysis experience with coal-gasification PDUs and pilot plants. Statistics on the relative frequencies of the various failure causes and on the components involved are summarized, and a number of specific component failures are discussed with respect to their causes and the effectiveness of corrective actions taken.

46831 **Method for enhancing the desulfurization of hot coal gas in a fluid-bed coal gasifier.** Grindley, T. To Dept. of Energy, Washington, DC. USA Patent 4,832,704. 23 May 1989. Filed date 5 Apr 1988. 8p. Available from Patent and Trademark Office, Box 9, Washington, DC 20232.

A process and apparatus for providing additional desulfurization of the hot gas produced in a fluid-bed coal gasifier, within the gasifier. A fluid-bed of iron oxide is located inside the gasifier above the gasification bed in a fluid-bed coal gasifier in which in-bed desulfurization by lime/limestone takes place. The product gases leave the gasification bed typically at 1600^0 to 1800^0F. and are particularly quenched with water to 1000^0 to 1200^0F. before entering the iron oxide bed. The iron oxide bed provides additional desulfurization beyond that provided by the lime/limestone.

0105 By-products

Refer also to citation(s) 46913

0106 Properties

Refer also to citation(s) 46791, 46803, 46820, 46822, 46826, 46863, 47313

46832 (CONF-8904133–1) **Multiple heteroatom containing sulfur compounds in coals.** Winans, R.E.; Neill, P.H. Argonne National Lab., IL (USA). [1989]. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From Symposium on geochemistry of sulfur in fossil fuels; Dallas, TX (USA); 9-14 Apr 1989. Order Number DE89016895/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Flash vacuum pyrolysis of a high sulfur coal has been combined with high resolution mass spectrometry information on aromatic sulfur compounds containing an additional heteroatom. Sulfur emission from coal utilization is a critical problem and in order to devise efficient methods for removing organic sulfur, it is important to know what types of molecules contain sulfur. A high sulfur Illinois No. 6 bituminous coal (Argonne Premium Coal Sample No. 3) was pyrolyzed on a platinum grid using a quartz probe inserted into a modified all glass heated inlet system, and the products characterized by High Resolution Mass Spectrometry (HRMS). A significant number of products were identified which contained both sulfur and an additional heteroatom. In some cases two additional heteroatoms were observed. These results are compared to those found in coal extracted and liquefaction products. 25 refs., 5 figs., 4 tabs.

46833 (DOE/PC/88912–T2) **Roles of additives and surface control in slurry atomization: Quarterly report.** Tsai, S.C. California State Univ., Long Beach, CA (USA). Jul 1989. 5p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-88PC88912. Order Number DE89017641/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Two polyethylene-glycol (PEG) mixtures which approximate the pseudoplastic behavior of 70 wt % utility ground coal water slurry have been atomized using a twin-fluid coaxial jet-atomizer. Since the velocity profile during atomization is not known, Newtonian liquids of known viscosities were also atomized for comparison. Preliminary results are reported. 5 figs. 1 tab.

46834 (ETDE-mf–0702751) **Studies on the water uptake capacity and pore structure of coal with a view to rock burst prevention.** Hewel-Bundermann, H. Technische Hochschule Aachen (Germany, F.R.). Fakultaet fuer Bergbau und Huettenwesen. 27 Feb 1987. 143p. (In German). Order Number DE90702751/JAW. Available from NTIS (US Sales Only), PC A07/MF A01.

In the framework of the research project on 'Development of Operational Safety Measures for Underground Workings under High Rock Pressure', initiated by the Land of North-Rhine Westphalia, the author investigated the problem of the effect of impregnation with water on the energy storage capacity of coal, i.e. the question whether long-term impregnation with water may prevent rock bursts. The investigations were carried out on a level of the Dickebank seam in a mine in the eastern Ruhr. This pilot study became the basis for a programme covering 32 seams of the Ruhr carbon, with coal grades ranging from gas-flame coal to anthracite. The studies

were supplemented by analyses of Provencal shining brown coal, Rhenish soft brown coal, anthracites from Ibbenbueren and Erkelenzer Horst, and Korean graphite. (orig.).

46835 (EUR–11796-EN) **Chemical characterisation of coal and coal products.** British Coal Corp., Stoke Orchard (UK). Coal Research Establishment; Commission of the European Communities, Luxembourg (Luxembourg). Feb 1988. 108p. Available from British Coal Corporation, Stoke Orchard (United Kingdom). Coal Research Establishment; Commission of the European Communities, Luxembourg.

The aim of the project was the application of new spectroscopic and chemical procedures to the analysis of coal. Particular emphasis was placed on studying the chemical environments of sulphur, nitrogen and sodium in coal, since these elements are associated with atmospheric pollution, and plant fouling and corrosion problems. The origins of these elements, their metamorphosis during coalification, and their implications for coal utilisation are discussed. 72 refs., 49 figs., 11 tabs.

46836 (NIPER–200) **The effect of degree of aromaticity and alkyl substitution of polyaromatic hydrocarbons on instrumental response factors.** Thomson, J.S.; Reynolds, J.W.; Yu, S.K.T.; Tang, S.Y.; Grigsby, R.D. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Sep 1989. 61p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC22-83FE60149. Order Number DE89000761/JAW. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Average gas chromatographic (flame ionization detection) and ultraviolet spectroscopic response factors and high resolution, low voltage, electron impact, mass spectroscopic sensitivities have been obtained for polyaromatic hydrocarbon mixtures from four different fossil fuels. These mixtures were obtained from neutral-aromatic fractions by "heart-cutting" 1- through 5-aromatic-ring compound types using charge-transfer liquid chromatography. Liquid chromatographic separation into fractions of a given number of condensed aromatic rings was verified independently using synchronized scanning fluorimetry. Gas chromatographic relative response factors for all fuels reached a minimum at three aromatic rings, and then increased again. Ultraviolet molar absorptivities of each ring number group at 254 nm were found to be similar for different boiling ranges within each fuel type studied, and generally agreed within a factor of two between fuel types. HR/MS sensitivities of 1- through 3-ring fractions were found to decrease for lower boiling fractions containing long alkyl chains, and increase as both boiling point and ring number of the fractions increased. 34 refs., 20 figs., 13 tabs.

46837 (PIRSEM–0252) **Solid phase coal liquefaction by mild hydrogenation. Solid NMR studies.** Legrand, A.P.; Sfihi, H.; Guinton, M.F.; Pregermain, S.; Carson, D.; Chiche, P. Centre National de la Recherche Scientifique, 75 - Paris (France). Programme Interdisciplinaire de Recherche sur les Sciences pour l'Energie et les Matiernes Premieres (PRISEM). 1985. 25p. (In French). Order Number DE89764069/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

High resolution NMR of coal during hydrogenation is studied. Aromaticity of 4 coals is determined by carbon 13 nuclear magnetic resonance. Aromaticity increases with hydrogenation and coal rank. Products obtained are distilled and tar, the distillation residue, are also investigated by NMR, in this case there is no correlation between aromaticity and carbon content but aromaticity decreases with the ratio H/C.

0108 Waste Management

Refer also to citation(s) 46791, 46813, 46825, 46831, 46846, 46865, 46872, 46873, 46874, 46875, 46876, 46879, 47078

46838 (CONF-8609134–, pp. 130-137) **Evaluation of an equilibrium speciation model for the acid aqueous iron sulfate system at 25°C.** Stipp, S.L. (Stanford Univ., CA (USA)). Lawrence Livermore National Lab., CA (USA). 1986. From Workshop on geochemical modeling; Fallen Leaf Lake, CA (USA); 14-17 Sep 1986. In *Proceedings of the workshop on geochemical modeling.* Order Number DE89008807/JAW. Available from NTIS, PC A09/MF A01.

A series of solutions with known concentrations of Fe(III), Fe(III), and SO_4 were prepared to cover the chemical composition and pH range commonly encountered in acid mine waters: $10^{-5} < Fe_T < 10^{-2}$m, $10^{-3} < SO_{4T} < 10^{-1}$m, $1 < pH < 4$ and ionic strength < 0.35 m. An ion speciation model was designed to calculate the concentrations of all species from the total concentrations of solute and H^+ (derived from pH) and the thermodynamic constants. From the species concentrations it was possible to calculate pe (probable error) and the charge balance error. This provided two independent parameters with which to test the consistency of the model. The model was found to be effective in predicting laboratory results for all waters. Slight discrepancies result from error in pH electrode measurements and from model parameter uncertainties such as activity coefficient estimations and equilibrium constants. Conditioning and calibration of the pH electrode in a buffer of similar concentration to the unknown proves necessary for measuring solutions with pH < 2.0. The model results are most sensitive to the method of calculating single-ion activity coefficients. Use of the Truesdell-Jones equation yields the closest agreement for measured and predicted pe. Model predictions are less sensitive to equilibrium constant uncertainties for the various iron, hydroxide, sulfate and bisulfate pairs. Of these, the uncertainty in the dissociation constant for $FeSO_4^+$ has the greatest effect.

46839 (CONF-8707212–, pp. 326-346) **Microbial dissolution of toxic metals from coal residues.** Francis, A.J. (Brookhaven National Lab., Upton, NY (USA)); Dodge, C.J.; Krishna, C.R. USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA); US-DOE Idaho Operations Office, Idaho Falls, ID (USA). 1987. DOE Contract AC02-76CH00016. From Biological treatment of coals workshop; Vienna, VA (USA); 8-10 Jul 1987. In *Biological treatment of coals workshop. Proceedings.* Order Number DE89010545/JAW. Available from NTIS, PC A20/MF A01.

Microbial dissolution of toxic metals from coal residues was studied under aerobic and anaerobic conditions. Aerobically, native autotrophic bacteria solubilized varying amounts of As, Cr, Cu, Mn, Ni, Pb, and Zn. Dissolution of the above metals was increased by severalfold when inorganic nutrients N and P were supplemented. Under anaerobic conditions native anaerobic bacteria solubilized significant amounts of Fe, Cr, and Mn when amended with carbon and nitrogen. Selective chemical extraction analysis of coal residues indicates the association of most trace metals with pyrite Fe-oxide, and a soluble phase, possibly ferric sulfate. These results indicate that the predominant mechanisms of microbial dissolution of metals from coal residues under aerobic conditions is direct bacterial oxidation of pyrite and acid production; under anaerobic conditions it is due to direct bacterial reduction of iron and manganese oxides and the release of trace metals coprecipitated with the oxides.

46840 (DOE/MC/23251–2730) **Nested-fiber filter for high-temperature and high-pressure particulate removal: Final report.** Litt, R.D.; Conkle, H.N. Battelle Columbus Div., OH (USA). Jul 1988. 94p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-86MC23251. Order Number DE89011700/JAW. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

Battelle developed a novel Nested Fiber Filter (NFF) for high-temperature and high-pressure particulate removal. This concept uses metallic fibers to form an interlocking nest with high voidage, and therefore low gas pressure drop at face velocities of 200 feet per minute. This pressure drop compares to that for typical bag filters with face velocities of 2–4 fpm. The high throughput of the NFF greatly reduces the required equipment volume and the associated capital cost. This project has established the collection mechanisms, cold model filtration and cleaning, and performance at high temperature (1600 F) and high pressure (6 atmospheres). Collection efficiencies are greater than 99 percent for a wide range of operating conditions. The performance criteria upon which the NFF was measured are: (1) the New Source Performance Standards and (2) turbine specifications. The NFF can meet both. Applications include Pressurized Fluidized Bed Combustion, Integrated Coal Gasification Combined Cycle and the coal-fired gas turbine. 9 refs., 35 figs., 8 tabs.

0109 Environmental Aspects

Refer also to citation(s) 46823, 47925

46841 (PB–89-194237/XAB) **Second review of new source performance standards for coal preparation plants. Final report.** Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards. Feb 1988. 77p. (EPA–450/3-88/001). Available from NTIS, PC A05/MF A01.

The new source performance standards (NSPS) for coal preparation plants (Subpart Y of 40 CFR Part 60) were reviewed by the U.S. Environmental Protection Agency for the second time. The industry and other government agencies were contacted to obtain data. The review found that the use of coal dryers and pneumatic coal-cleaning equipment is declining, and that no new technology exists for these facilities. Technology exists for more-stringent control than required by the NSPS for sources of fugitive emissions from coal transfer, handling, and storage facilities because of recent application of high efficiency control equipment for particulate emissions.

0120 Mining

Refer also to citation(s) 46834, 46886, 46888, 47691, 47693, 47694, 47695

46842 Effect of volatility on dust flammability limits for coals, gilsonite, and polyethylene. Cashdollar, K.L. (Department of the Interior, Pittsburgh, PA (USA)); Hertzberg, M.; Zlochower, I.A. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Lean limit concentrations and limestone rock dust inerting requirements were measured in a 20 chamber for a range of carbonaceous dusts including various ranks of coal, gilsonite, and artificial mixtures consisting of polyethylene and graphite. Although there is some uncertainty in the true yield of volatiles for some of the fossil mineral dusts, especially at flame flux levels, the data show that the combustible volatile content of the carbonaceous dusts is the dominant factor governing their combustion behavior in the dust explosions. The char residues and graphite are essentially inert on the rapid time scale required for flame propagation processes in explosions. The lean flammability limits of the various dusts correspond to invariant combustible volatile concentrations of about 30 to 40 g/m^3. Total inerting of the dusts occurs when the inert content of the mixture exceeds about 90 to 95 wt pct. The char's role is equivalent to that of the other inert constituents, such as ash and rock dust. Volatile yields of the various coals were measured using a high power, carbon dioxide laser at flux levels of 110 to 115 W/cm^2. These measurements provide new data on the volatilities of 110 μm particles of the various coals, but some uncertainties remain in the absolute volatilities of the various sized coals used for the 20 tests. A relatively simple volatility model for the various fossil mineral dusts can be used to explain their explosion propagation behavior and their extinction limits. When the uncertainties in volatility were removed by using the artificial mixtures of a completely volatilizable fuel (polyethylene) and the nonvolatilizable graphite, the model was confirmed.

46843 (ETDE-mf–0702697) **Measuring and control system for coal ploughs - development of a method for identification of the seam/rock interface. Final report.** Reisner, G. Ruhrkohle A.G., Essen (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). Dec 1988. 122p. (In German). Contract BMFT 032-6483-A;RAG 525. Order Number DE90702697/JAW. Available from NTIS (US Sales Only), PC A06/MF A01.

The research project was aimed at development and design of a functional scheme of an optical sensor system wich allows permanent identification of the coal/rock interface during ploughing. The system consists essentially of the transmitter/receiver unit, a lightwave bundle, and an evaluation unit. The light emitted by selected emission diodes - wave lengths 850 nm and 1550 nm - was directed via the lightwave conductor bundle and a sensor head with integrated sapphire crystal in frictional contact with the floor immediately behind the floor pick onto the coal/rock interface, and the reflected light beam components were received. The energy supply of the whole system was assured by an intrinsically safe battery. The different reflectance data of coal and rock allow clear destinction of coal and rock if the received signals are evaluated properly. (orig.) With 9 tabs., 35 figs.

46844 (PB–89-189922/XAB) **Evaluation of air sprays and unique foam application methods for longwall dust control. Research report (Final).** Laurito, A.W.; Singh, M.M. Engineers International, Inc., Westmont, IL (USA). Aug 1987. 109p. Available from NTIS, PC A06/MF A01.

See also DE88013132.

This study evaluated two novel dust-control techniques for longwall mining sections. The two systems, foam and air sprays, were evaluated in the laboratory, and the foam system was field tested in three operating mines. Dust reductions between 13% and 80% were achieved during the field evaluations of the foam dust suppression system. The report describes the laboratory investigations and the field evaluations of the foam system with the results and conclusions.

0130 Transport and Handling

Refer also to citation(s) 46827, 47079

46845 (DOE/PC/90517–T3) **Extruded coal capsules for transport in fiber-water flow: Final technical report.** Liu, H.; Marrero, T.R. Missouri Univ., Columbia, MO (USA). Coll. of Engineering. 15 Jun 1989. 66p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-86PC90517. Order Number DE89015594/JAW. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The purpose of this research project was to explore the basic concepts and the technical feasibility of using pipelines to transport extruded coal capsules, called "coal logs," without having to enclose the coal in containers. Such a system appears to have all the advantages of HCP (Hydraulic Capsule Pipeline), such as low energy consumption, low water consumption, and low dewatering cost, plus the main advantage of slurry pipelines: only a single pipeline is required for coal transport. A broad range of research activities were conducted including: (1) testing various kinds of binders for coal log extrusion; (2) testing the physical and burning properties of coal logs; (3) testing the hydraulic and transport properties of coal logs including hydrodynamic test and wear (abrasion) test; (4) testing the effect of fiber (wood pulp) added to the flow for reducing drag and wear; and (5) analyzing the technical and economical feasibility of coal log pipeline transportation of coal. The hydraulic test, wear test and fiber-effect test were all conducted using both a small (2-inch-diameter, 75-ft-long) pipe loop and a large (8-inch-diameter, 450-ft-long) pipe loop. Coal logs of several diameter ratios were circulated through these pipes. Results of the tests were recorded, analyzed and plotted by an on-line digital computer with A-to-D conversion capability. 9 refs., 31 figs., 16 tabs.

0140 Combustion

Refer also to citation(s) 46791, 46824, 47305, 47312, 47313, 47314, 47557, 47558, 47559, 47953

46846 Stationary combustion: The environmental leitmotiv. Beer, J.M. (Massachusetts Institute of Technology, Cambridge (USA)). pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Combustion and pollutant formation are inseparable processes. Because of the central role of direct fossil fuel utilization in the provision of heat and power for the foreseeable future, major efforts are being made to ameliorate the environmental effects. The most cost-effective way of reducing pollutant emission is the modification of the combustion process. Combustion scientists and engineers have developed new clean combustion technologies based on the better understanding of the physical-chemical bases of NO_x formation and destruction in flames, the capture of SO_2 by additive sorbent or ion-exchangeable alkali compounds, the formation and destruction of PACs, and the formation of fine inorganic aerosols in

high temperature combustion processes. New information has become available on the mechanism of coal combustion, on the effect of fragmentation of coal and char particles upon the rates of heterogeneous reactions of carbonaceous solids and on the development of the fly ash size distribution. It is of interest to note that while it is combustion chemistry that provides guidance for the development of combustion processes with reduced pollutant emission, the realization of the required concentration-temperature history of the fuel in furnaces, boilers and combustors represents a challenge to combustion physics, notably fluid dynamics and heat transfer. 61 refs.

46847 The role of peripheral percolation in detachment of fines from burning carbon particles. Salatino, P. (Istituto di Ricerche sulla Combustione, Napoli (Italy)); Massimilla, L. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Batch combustion of graphite spheres and char particles made by devolatilization of a South African coal has been carried out on a grate and in a fluidized bed. 0.04 m ID combustors equipped with a two-exit head have been used. Overall amount of carbon fines formed during a combustion test as well as time-resolved curves of carbon fines generation rates were obtained with this apparatus. Temperatures were varied within ranges 660 to 820 C and 400 to 550 C for graphite and South African char, respectively. Optical microscopy and computer aided image analysis were used to measure sizes of carbon fine particles (up to 250 μm) collected during combustion. A 2-D percolation model, based on Monte Carlo simulations for a square lattice, has been developed to obtain qualitative trends on the influence of peripheral percolation in actual combustion of carbon particles. Percolation is the only source of fines generation in combustion on grate and, and a consequence, when conversion rate is controlled by external diffusion, fractional carbon loss due to fine generation is very small, namely less than 1%. Experimental results are in agreement with these expectations. Conversion rate control in practical fluidized combustion is also dominated by external diffusion, so that, even in this case, the loss of carbon should be that small. Actual loss, more than one order of magnitude larger, is due to attrition by abrasion of particles which by far overtakes peripheral percolation in producing carbon fines.

46848 Weak homogeneous burning in front of a carbon surface. Henriksen, K. (Institut fur Allgemeine Mechanik, Aachen (Germany, F.R.)). pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The combustion of a carbon surface exposed to a stagnation point flow field is investigated theoretically. Assuming a one-step unidirectional homogeneous reaction, an asymptotic analysis in the limit of large gas phase activation energy is derived for the regime of weak homogeneous burning. In this case neither the fuel CO, which is produced by the heterogeneous reactions, nor the oxidizer O_2 are totally consumed in the homogeneous reaction zone in front of the carbon surface. A simplifying correspondence between the present problem and diffusion flames in normal two-feed systems is achieved through transformation of the governing equations to the mixture fraction as the independent variable and through introduction of a hypothetical fuel stream. The comparison of complete numerical solutions with results of the asymptotic analysis shows that the usual assumption, which lead to the well-known nearly frozen and partial-burning solutions, are not valid in the case of carbon combustion. Thus a modified analysis based on more general assumptions is developed. This modification takes into account the gradual detachment of the maximum temperature from the carbon surface with an increasing homogeneous Damkoehler number. Furthermore, the influence of the carbon surface on the homogeneous reaction zone is always included. The present weak burning analysis contains the nearly frozen as well as the partial burning solutions as limiting cases. Good qualitative and quantitative agreement with complete numerical solutions is obtained for the evaluation of combustion rates of carbon and the prediction of gas phase ignition limits.

46849 Promotion of char oxidation by inorganic constituents. McCollor, D.P. (Combustion and Environmental Systems Research Institute, Grand Forks, ND (USA)); Jones, M.L.; Benson, S.A.; Young, B.C. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). DOE Contract FC21-86MC10637. From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A North Dakota lignite has been demineralized and selectively reloaded with calcium, potassium, and sodium cations by an ion-exchange process. Chars produced from the treated samples were burned in a laminar-flow reactor and single-particle temperatures were determined by optical pyrometry. Results show that sodium and potassium cations present in the chars have little effect on the char particle temperatures or burning rates. Calcium cations enhance the char particle temperatures at low concentration (<5,000 ppm). The results are consistent with carbon dioxide being produced at the char surface by catalytic action of the char mineral matter.

46850 On the products of the heterogeneous oxidation reaction at the surfaces of burning coal char particles. Mitchell, R.E. (Sandia National Laboratories, Livermore, CA (USA)). pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The combustion of the char particles of two bituminous coals were investigated in a laminar flow reactor having gaseous environments containing 6 and 12 mole-% oxygen in the temperature range 1550 to 1700 K. Measurements of the size, temperature and velocity of individual particles were made at selected heights above the reactor inlet and hence, at different extents of burnoff. Samples of partially reacted chars, extracted from the reactor at these same heights, were analyzed in order to determine the fraction of the initial mass remaining, m/m_0, and the char density. The data were used in the governing mass, momentum and energy balance equations in order to determine overall particle burning rates per unit external surface area. The burning rates determined indicate that account must be made of CO_2 formation in the vicinity of the particle. Whether the CO_2 is formed heterogeneously at the particle surface, or homogeneously in the particle's boundary layer cannot be established definitively. It is shown, however, that the single-film model of a burning carbon sphere with a fraction ψ of the carbon being converted to CO_2 at the particle surface adequately describes the burning behavior of coal char particles in the 75 to 125 μm size-range. Employing such a model, for the char particles of the bituminous coals investigated, as much as 15% of the carbon content of the particle can be converted to CO_2 at temperatures in the range 1600 to 1700 K. At temperatures above 1800 K. CO is essentially the sole heterogeneous reaction product.

46851 Combustion of coal char agglomerates in a combustion gas environment. Kawaguchi, Osamu (Keio Univ., Yokohama (Japan)); Noto, Takashi. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Coal char agglomerates produced at the latter stage of coal-oil or coal-water slurry spray combustion are studied using artificially-made coal char agglomerates suspended on a fine quartz fiber in the post-combustion zone of a methane premixed flat flame. The size and mass of the burning agglomerate were measured after exposure to the hot environment for a short time. The apparent density of the agglomerate was calculated from the measured mass and size. The external appearance of the agglomerates was also observed using a scanning electron microscope (SEM). The char agglomerate in a hot combustion gas decreases in size until the carbon is burned up and only the ash remains. The apparent density continues to decrease as long as the carbon contained reacts and then increases till the size changes no more. The final apparent density is almost equal to or exceeds the initial density. The relation between the apparent density and the carbon mass reduction is linear, independently of the surrounding combustion gas conditions. These results mean that at the combustion of a char agglomerate progresses, the agglomerate comes to have porous structure composed of ash. Changes in coal type changes combustion characteristics. The ash content and ash melting point control the burning rate and carbon mass consumption rate due to generation of an ash layer around the char core. However, the fuel ratio of the

raw coal influences the porosity of the char agglomerate, which promotes carbon reaction with the environment.

46852 Modeling the devolatilization behavior of high volatile bituminous coals. Niksa, S. (Stanford Univ., CA (USA)). pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A model for the devolatilization of high volatile bituminous coals developed by analogy with a single-stage, equilibrium flash distillation is evaluated against measured rates and yields of tar and noncondensible gases, and the size characteristics of tar. As seen in the comparison with data, the model accurately correlates transient weight loss for heating rates from 440 to 3300 K/s for temperatures to 1300 K; the ultimate distribution of the volatile products for pressures to 0.5 MPa; and the molecular weight distributions of tars prepared in atmospheric pyrolysis at temperatures to 1200 K. The tendency to form lighter tar at elevated pressures is also explained. The theory predicts that yields are insensitive to heating rate at moderate temperatures, in accord with wire-grid experiments, but conditions where tar yields are substantially enhanced by more rapid heating are also identified. Hence, the influences of all of the important operating conditions on the devolatilization of high volatile bituminous coals can be understood in terms of only three mechanisms: (1) the disintegration of the coal macromolecule into primary fragments which are widely distributed in size; (2) the partitioning of the primary fragments into volatile and condensed species according to a phase equilibrium for continuous mixtures; and (3) competitive char formation in the condensed phase with the simultaneous evolution of noncondensible gases.

46853 Correlations for effects of coal type and pressure on tar yields from rapid devolatilization. Ko, G.H. (Massachusetts Institute of Technology, Cambridge (USA)); Sanchez, D.M.; Peters, W.A.; Howard, J.B. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). DOE Contract AC21-85MC22049. From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A correlation relating maximum tar yield from rapid pyrolysis (heating rate ≈100-1000C/s) to coal type and total pressure is presented. The tar yield predicted from the correlation represents the maximum amount of tar to be expected during the devolatilization phase of the coal combustion process. Coal-type effects are treated using only information on the elemental C, H, O, and S analysis of the unpyrolysed coal. Pressure effects are correlated via empirical parameters obtained from best-fit analyses of existing data. The correlation is tested against a large set of experimental data representing a wide range of coals (37 coals, ranging from lignites to anthracites) and pressures (vacuum to 9 MPa). Good agreement between the predicted and experimental yields are obtained for all coals and pressures, with a standard error of estimate of ±3 wt% dmmf. This result is a significant improvement over predictions from existing correlations.

46854 Laser pyrolysis of single coal particles in an electrodynamic balance. Phuoc, T.X. (Department of Energy, Morgantown, WV (USA)); Maloney, D.J. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A novel method has been developed to study the rapid devolatilization behavior of single coal particles. The objective was to establish a general understanding of the controlling mechanisms for coal devolatilization and to determine some characteristic times for volatile evolution at energy fluxes representative of heat engine combustors. Single coal particles were suspended electrodynamically and irradiated from two sides with well characterized energy pulses. Heavy volatiles (condensible) evolution during the heating process was clearly time resolved using high-speed cinematography. Experiments were performed on two particle size fractions (30 and 60 μm nominal radius) of a HVA bituminous coal. The devolatilization process was divided into three phases. Phase I represented the time required to heat the particle to the temperature at which light volatile (noncondensible) evolution commenced. This phase was particle size and heat flux dependent with the most important consideration being the particle surface temperature. Phase II involved softening of the particle surface layer. This phase was particle size independent but was strongly dependent on the incident heating flux. Phase III was the time over which heavy volatiles (condensible tars) release occurred. This phase was strongly particle size dependent and was only weakly coupled to the heating intensity. These results suggest a sequential model to describe coal devolatilization which considers heat transfer, chemical kinetics, and mass transfer mechanisms whose relative importance varies depending on which phase of devolatilization is considered.

46855 Pyrolysis-induced changes in the ring number composition of polycyclic aromatic compounds from a high volatile bituminous coal. Wornat, M.J. (Massachusetts Institute of Technology, Cambridge (USA)); Sarofim, A.F.; Longwell, J.P. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Combining a high pressure liquid chromatographic separation by ring number and a mass proportional means of detection, the authors have monitored the pyrolytic behavior of nonpolar coal-derived polycyclic aromatic compounds (PAC) at temperatures of 1100-1500 K and average gas residence times of .25 to .75 sec. PAC composition with respect to ring number correlates well with total PAC yield (or conversion) and depends on temperature or time only as much as these variable determine conversion. 2- and 3-ring aromatics decay the most rapidly with increases in temperature or time; 4- and 5-ring PAC emerge as the most stable species. As a whole, PAC of 6 to 10 rings exhibit general insensitivity to pyrolysis conditions up to an intermediate level of conversion, after which they too decay with increasing temperature or time. Ring number analyses on substituted and unsubstituted PAC fractions of the coal pyrolysis samples reveal that for each ring number group, the substituted PAC decay more quickly than the unsubstituted PAC. The departure of product concentrations from equilibrium levels indicates kinetic control. In contrast to premixed flame systems where PAC and soot grow by the addition of acetylene, aromatic species appear to be primarily responsible for the growth of the PAC and soot in the coal pyrolysis experiments.

46856 Particle rotation in coal combustion: Statistical, experimental and theoretical studies. Kang, S.W. (Massachusetts Institute of Technology, Cambridge (USA)); Sarofim, A.F.; Beer, J.M. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Fast particle rotation (up to 3,000 cycles/sec) was observed and recorded by high-speed cinematography and fiber optic radiometry during the combustion in a laminar flow reactor of coal particles and coal-water fuel (CWF) agglomerates. A theoretical model of particle rotation developed to predict the angular velocity of rotating coal particles or CWF agglomerates during devolatilization and char burnout is based on volatile ejection from pores, assumed to be randomly oriented. The angular velocity of the rotating particle is shown to be dominated by the volatiles ejected from a small number of macropores and dependent upon the particle heating rate and particle size. Because of the random pore distribution, a range of geometrical factors for the devolatilization pores is predicted by the model, in general agreement with the statistical results on the rotation frequency distribution observed experimentally.

46857 Coal combustion models for flame scaling. Truelove, J.S. (Univ. of Newcastle (Australia)); Williams, R.G. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A theoretical model of a coal flame is applied to interpret and extrapolate pilot-scale test furnace data. The flame model is based on the equations governing conservation of mass, momentum, species and energy and includes physical models for turbulence, volatiles combustion, radiation heat transfer and particle dispersion together with phenomenological models to describe coal devolatilization and char combustion. Predictions of flow, temperature and species concentration are compared with measurements in the near-burner ignition zone of pilot-scale and full-scale-boiler flames. Agreement between the predictions and data is generally encouraging. The

predictions suggest, and the measurements confirm, that flame characteristics near critical ignition are particularly sensitive to burner operating conditions. Test-furnace data for new high-moisture coals are extrapolated to predict flame stability for the thermal conditions in a full-scale boiler.

46858 **The prediction of swirl burner pulverized coal flames.** Lockwood, F.C. (Imperial College of Science and Technology, London (England)); Mahmud, T. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

This paper describes a validation study effected on a computational procedure for the prediction of pulverized coal combustion. The present study relies on data collected in this laboratory which, although limited because of the difficulty of measurement in PF flames, have code validation as their primary purpose. The swirl number of 0.78 is for the most part higher than those of past studies and it is typical of industry practice. The near-burner field, all important to emissions and flame stability performance, is empathized. The quality of the gas temperature and concentration predictions for these more demanding circumstances is, while acceptable for some purposes, less than notable. It is concluded that the analytical development of PF combustion predictive codes has now outstripped the parallel demand for their step by step validation, at least as far as the near field of a typically operated swirl burner is concerned. The search for the source of the predictive deficiency is seriously impeded by the current inability to make reliable two phase velocity measurements in fully turbulent and real burner flames. It appears that the simulation of the particle response to the mean and fluctuating gas field is less than satisfactory. Some two phase data for small scale, but turbulent, inert flows exist which have not been fully exploited. Measurements of simultaneous char particle fluxes and burnouts and of char particle residence times are feasible but scarce, they should be indulged in the next phase of validation effort.

46859 **An analysis of the behavior of non-slagging, coal fired, cyclone combustors using a phenomenological model.** Morgan, D. (Univ. College, Cardiff (England)); Biffin, M.; No, S.Y.; Syred, N. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A phenomenological model has been used to analyze the behavior of the internal aerodynamic processes and particulate motion occurring in non-slagging coal fired cyclone combustors. The model includes boundary layer effects on the outer, top and bottom walls, a shrinking core/fragmentation model of coal combustion and momentum coupling between flow and particle dynamics. A non-slagging cyclone combustor operates normally fuel rich at a mixture ratio of about 0.7 to maintain cyclone chamber gas temperatures below 1300 C and wall temperatures about 1100 C. With a crushed coal of size range $\bar{}d_m \cong 200 - 400$ μm 90% < 1 mm, having a high ash fusion temperature, good fuel burnout and retention of particles larger than 30 μm in the cyclone chamber has been demonstrated. The long residence times of material in the outer regions of the cyclone chamber causes a large slip velocity between that of the inlet and the main vortex in the cyclone chamber and this factor affects the design of the tangential inlet. Burnout of the gasified products of combustion was achieved in a secondary combustor. Low NO_x emissions derive from the low operating temperatures of the primary cyclone chamber.

46860 **Development of slag-tap combustor for high intensity pulverized coal combustion.** Sadakata, Masayoshi (Gunma Univ., Kiryu (Japan)); Sakai, Takeshi; Tominaga, Hiroaki; Yamamoto, Soichi; Suzuki, Koji. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A new type slag-tap coal combustor was developed for high intensity pulverized coal combustion. In advance of experiment, a simple aerodynamic analysis of particle motion was carried out and it was predicted that the combination of Rankine vortex at the upper part and forced vortex at the lower part could offer both the long residence time of coal particles in the furnace and higher ash removal efficiency. The cold model experiment showed that the two step air injection method - the weak swirl air injection at the upper part and the strong swirl air injection at the lower part - could approximately realize an above flow pattern. Hence, a new test cyclone combustor with a two-step air injection was designed and constructed. The combustion experiment using this test furnace showed that the two step air injection method could give high combustion efficiency, high slag-removal efficiency and low NO_x and CO simultaneously.

46861 **The use of nonsymmetrical jets for the stabilization of low grade coal flames.** Wu, C.K.; Chen, L.F.; Li, J.; Wang, H.Y.; Wei, J.B.; Zhan, H.Q; Zhu, F.Y. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Two new aerodynamic methods of flame stabilization have been developed which are especially suitable for low grade pulverized coals or coal-water-slurries. One is based on the Coanda effect, which causes the flat inlet jet of air to attach to the bottom of the precombustion chamber and creates a large recirculation in the upper half of the chamber with strong turbulence and mixing. The inertia of the coal particles projects them into the high temperature zone, thus they quickly ignite and burn, leading to a stable flame. The other is based on an off-axis, slightly tilted primary jet, which produces a three-dimensional flow-field with large recirculation and good mixing. The distribution of coal is also favorable for stable combustion. Both these methods have been developed through experimental and computational cold flow studies, laboratory combustion tests and industrial scale tests. LDV studies were made in plexiglas models, and numerical simulation corroborated the experimental results. With their usefulness and reliability demonstrated on industrial installations, many utility and industrial boiler operators in China are installing them for startup and part-load flame stabilization to conserve the large quantity of oil presently used for these purposes.

46862 **Spontaneous combustion in beds of coal particles.** Tognotti, L. (Universita' di Pisa (Italy)); Petarca, L.; Zanelli, S. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

This paper describes a simple experimental technique to determine the ignition temperature of various cylinder-shaped beds (diameter 17-160 mm, height 10-80 mm) of a South African coal and reports the application of thermal ignition models in interpreting and extrapolating the small scale results. Measurements of the rate heat generation in isothermal conditions are also reported and compared with the results of ignition tests. The coal used in this work was found to undergo spontaneous ignition in small scale tests at temperature from 120 to 220 C. The thermal ignition model provides a good correlation for critical ignition temperature of bodies of different sizes. The correlation has proved to be relatively insensitive to complications in reaction (oxygen interparticle diffusion) and to physical changes in the material (reactant consumption), but it depends on the boundary conditions (Biot number). An effect of coal particle sizes indicates the existence of intraparticle diffusion limitations. Comparison between ignition and thermal data yields a satisfactory agreement in prediction of critical dimension by means of the thermal ignition model. Small scale tests have been extrapolated and examples of prediction of critical dimensions at different temperatures are also reported.

46863 **Application of FT-IR emission/transmission (E/T) spectroscopy to study coal combustion phenomena.** Solomon, P.R. (Advanced Fuel Research, Inc., East Hartford, CT (USA)); Chien, P.L.; Carangelo, R.M.; Best, P.E.; Markham, J.R. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). DOE Contract AC21-85MC22050;AC21-86MC23075. From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

This paper describes the application of a recently described Fourier Transform Infrared (FT-IR) Emission and Transmission (E/T)

technique to study coal flames produced in a transparent wall reactor. Comparisons are made for the ignition, soot formation, particle temperature and gas temperature for a number of coals varying in rank from lignite to low volatile bituminous. Samples of chars prepared at different temperatures and demineralized coals were also studied. Flame properties were compared with characteristics of the samples to determine the factors which control flame behavior. A comparison of the ignition of several samples suggests that the rate of ignition correlates with the initial rate of weight loss in air in a TGA experiment at lower temperatures. Ignition of chars is heterogeneous; ignition of high rank coals is homogeneous; but low rank coals exhibit both homogeneous and heterogeneous contributions to ignition. Soot formation in combustion correlates well with tar yield in pyrolysis suggesting that tar is the chief precursor of soot.

46864 Rapid pyrolysis and combustion of pulverized Montana Rosebud subbituminous coal. Haussmann, G.J. (Stanford Univ., CA (USA)); Kruger, C.H. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The pyrolysis and combustion of narrowly size-graded pulverized Montana Rosebud subbituminous coal has been studied in an entrained-flow reactor which allows independent control of the gas temperature (1150 K-1750 K) and oxygen concentration (0-15%), with a dilute particle loading to eliminate inter-particle interactions. The use of both gas and solids sampling provides independent characterizations of the extend of pyrolysis and combustion. At high gas temperatures (1750 K) rapid pyrolysis is observed, with ultimate pyrolysis yields reached within 11 msec. Physical analysis of the partly reacted chars quantitatively confirm the pyrolysis yields based on gas sampling, with a rapid formation of voids within the particles and ejection of mass (before 11 msec), and relatively little change thereafter. Gas sampling indicates carbon conversion during pyrolysis of 29% at 1540 K and 40% at 1750 K. Carbon-containing pyrolysis products include CO, CO_2, light hydrocarbons and tar; nitrogen is detected primarily as HCN, with smaller amounts of NH_3. Under oxidizing conditions, even at oxygen concentrations as low as 2.0%, these pyrolysis products are oxidized at early residence times, and virtually no hydrocarbons, tar, HCN or NH_3 are detected. Following pyrolysis, diffusion-limited char combustion is observed at 2.0% O_2, with a transition from zone III to zone II kinetics as the oxygen concentration increases from 2.0% to 15%.

46865 Time-resolved evolution of fly ash during pulverized coal combustion. Kang, S.G. (Massachusetts Institute of Technology, Cambridge (USA)); Helble, J.J.; Sarofim, A.F.; Beer, J.M. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). DOE Contract AC22-86PC90751. From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The time resolved evolution of ash during the combustion of individual char particles has been studied using a Montana lignite, a North Dakota Beulah lignite, and a synthetic char prepared from doped sucrose. The three chars were selected to illustrate the effects of macroporosity and mineral matter content on the ash evolution. The synthetic char is distinguished from the lignites by being macropore-free. The ash content was varied from 17% (Montana) to 37% (Beulah). When the chars are reacted under external-diffusion-controlled conditions, the mineral matter is released as the carbon surface recedes. The ash particles on the surface of the char aggregate and grow in size with increasing char burnout. The rate of growth of particle size increases markedly as the extend of burnout increases because of the increase in surface concentration of released ash. The ash sizes are larger for the char with the higher mineral content. As complete burnout is approached, however, the macroporous lignite chars fragment yielding smaller final ash particles than the macropore-free sucrose char. A percolation model applied to the ash formation processes was used to demonstrate the major features of the dependence of the time resolved evolution of ash on macroporosity.

46866 Quench-induced nucleation of ash constituents during combustion of pulverized coal in a laboratory furnace. Scotto, M.V. (Univ. of Arizona, Tucson (USA)); Bassham, E.A.; Wendt, J.O.L.; Peterson, T.W. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). DOE Contract AC21-84MC21386;AC22-86PC90751. From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The hypothesis that nucleation of ash constituents in practical coal combustors can be influenced by the temperature quench rate was tested in a laboratory 2-5 kg/h pulverized coal furnace. Two Beulah lignite coals, similar in heating value and overall ash content but differing in the sodium content, were tested. Ash samples were withdrawn at various residence times down the combustor, segregated by size, and analyzed for their bulk, surface and interior composition. Increasing temperature quench rate beyond 400 K/s significantly increased the fraction of the inlet sodium appearing in the small particle size range. This was because a sodium-rich fume was frozen in the particulate phase during temperature quench, although surface enrichment of the sodium on the larger particles was also realized under these conditions. Subtle differences in these otherwise similar coals appeared to exert a large influence on the primary mechanisms forming the small particles. Although the low sodium coal contained approximately half the sodium of the other, it yielded less than one tenth of the amount of sodium in the small particle size range. Furthermore, while results for one coal supported a silicon vaporization/nucleation mechanism governing formation of small particles, those for the other coal did not.

46867 The production and loss of char fines during fluidized bed combustion of a high volatile bituminous coal. Walsh, P.M. (Massachusetts Institute of Technology, Cambridge (USA)); Dutta, A.; Cox, R.J.; Sarofim, A.F.; Beer, J.M. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). DOE Contract FG22-80PC30215. From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A substantial fraction of the fixed carbon feed appears as char fines entrained in the flue gas from bubbling atmospheric pressure fluidized bed combustion (AFBC) of bituminous coal. Incomplete conversion of these fines usually represents the most significant combustibles loss from such a system. The division of fixed carbon between burned char and fines is influenced by bed temperature, excess air, and superficial velocity only to the extend that the initial porosity and porosity at fragmentation depend upon these conditions. This concept was used as the basis of a model for carbon conversion in AFBC. The model was tested by comparison with bed carbon loads measured during combustion of Kentucky No. 9 coal in a 0.6 x 0.6 m bed. Comparison of predictions based on alternative approximations indicated there was relatively little combustion of char fines in the bed; most were carried unburned into the freeboard region. Total carbon conversion (fixed plus volatile) at the top of the bed was estimated to have been only 56 $\pm$ 9%. Low carbon conversion is seen to be the consequence of char fines production by fragmentation during combustion of larger particles, the relatively short freeboard must account for a significant fraction of the overall carbon conversion in an efficient unit. More attention should be given to freeboard residence time and temperature in designing for improved combustion efficiency.

46868 Coal fragmentation in a fluidized bed combustor. Ragland, K.W. (Univ. of Wisconsin, Madison (USA)); Pecson, F.A. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The fragmentation behavior of a Colorado bituminous, a Montana sub-bituminous and a Texas lignite coal during combustion in a 0.3 m by 2.1 m atmospheric fluidized bed was investigated. A sampling probe was developed to remove bed samples at different times, enabling the temporal determination of the number, size distribution, density, and surface appearance of the char particles. Fragmentation depends on coal type, weakly on bed particle size and not on fluidization velocity. Microphotographs of the char particles show distinctive surface fissures with a cell size of 0.2 mm for lignite and an order of magnitude greater for bituminous and sub-bituminous coal. Most of the fissure lines do not lead to fractures, but some secondary fragmentation does occur. Particle size distributions

curves are presented. The coal feed had a narrow size distribution with a surface mean diameter of 5 mm, and the overall char size distribution was broader with the surface mean diameter reduced by a factor of two due to fragmentaion. Calculations were made to separate the effects of size reduction due to burning and attrition from fragmentation.

46869 Primary fragmentation of a coal in fluidized bed combustion. Chirone, R. (Istituto di Ricerche sulla Combustione, Napoli (Italy)); Massimilla, L. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Experiments of primary fragmentation of a bituminous, nonswelling South African coal have been carried out by injecting irregular particles, spheres and cubes of size ranging between 1 and 15.5 mm in a basket-equipped fluidized bed combustor of 40 mm ID. Separate experiments have been carried out in order to determine average tensile strength of coal at different temperatures and its dispersion around the average due to non-homogeneities of material. A model of primary fragmentation has been developed. It is made of a serial structure of four submodels which account for the heatup of coal particles in the bed, the kinetics of devolatilization, the volatile convective transport and build up of pressure in the particle pore network and, according to the statistical theory of Weibull, the fragmentation of particles when internal pressure force overcomes the resistance force of the material. The basic model assumes spherical symmetry of coal particles. A modified version considers that non-spherical fragments still rich in volatiles may experience further fragmentation as if they were fresh spheres of equivalent diameter. The study shows that effects of primary fragmentation may noticeably influence fluidized combustion behavior of coal tested particularly in the case of coarse feed. Probabilities of particle fragmentation, multiplication factors of the number of particles, average sizes of fragmented material predicted by the modified model are in good agreement with experimental results.

46870 Mass transfer processes around burning char particles in fluidized beds. Agarwal, P.K. (Univ. of Adelaide (Australia)); Mitchell, W.J.; La Nauze, R.D. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The detailed modelling of the fluidized bed combustion of coal depends on the elucidation of the mass transfer processes around large active particles in fluidized beds of smaller inert particles. Experimental techniques based on naphthalene sublimation as well as carbon combustion have been used to obtain mass transfer data for this configuration. In previous modelling studies the active particle has been considered to reside only in the emulsion phase. In this paper, the effect of active particle motion on mass transfer is considered. The active particle is assumed to reside alternately in the bubble and emulsion phases. By considering this particle motion in conjunction with the gas flow distribution, expressions are obtained for the appropriate Sherwood numbers in each phase. Using the emulsion phase residence probability, an expression for the overall Sherwood number is developed. The results of the model calculations are compared favorably with experimental data reported in the literature for fixed as well as fluidized beds.

46871 A combined oxygen/bubble probe for the study of fluidized bed combustion of volatiles. Stubington, J.F. (Univ. of New South Wales (Australia)); Chan, S.W. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A combined probe has been developed to study the combustion processes occurring within the bed of a fluidized bed combustor. This probe is capable of simultaneously detecting bubbles and monitoring the oxygen concentration at a single position in the bed. It consists of a Zirconia-based oxygen sensor located vertically between the two tips of a differential pressure probe. The probe time constants are less than or equal to 0.02 s and 0.01 s, so that it is not only capable of measuring the oxygen concentration in bubble and particulate phases, but can also detect gas composition changes within the bubble itself. Computerized signal analysis techniques have been developed to provide corresponding binary signals indicating the presence at the probe of bubble/particulate phase and oxygen/fuel rich regions, for subsequent statistical analysis. In preliminary experiments of volatiles combustion, the probe data on bubble characteristics and oxygen partial pressures are consistent with the literature results obtained using individual probes.

46872 Reduction of NO_x emissions in a swirled coal flame by particle injection into the internal recirculation zone. Smart, J.P. (International Flame Research Foundation, IJmuiden (Netherlands)); Knill, K.J.; Visser, B.M.; Weber, R. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

An internally air staged burner was designed and used to measure the possible reduction of NO_x in a swirling pulverized coal flame. Two flames, generated by varying the coal gun position, were studied using a 2.5 NW burner. The NO_x emissions were reduced by inserting the coal gun into the burner quarl. This increased the fraction of coal particles injected into the oxygen lean, internal recirculation zone (IRZ) where the coal volatile nitrogen species were preferentially reduced to N_2. Inflame nitrogen chemistry was observed by measuring the temperature and concentration of major gas species, NO_x, HCN and NH_3. As well, finite difference modeling of the two flames was used to predict the particle trajectories. By adjusting the fraction of coal injected into the IRZ, the NO_x emission level could be reduced from 1300 ppm (little particle penetration into the IRZ) to 500 ppm (complete particle penetration). The burnout was unaffected by adjusting the coal gun position as the carbon content of the ash was less than 3% in both flames. Predicted particle trajectories were supported by particle paths deduced from the gas species measurements. Thus, a minimization of NO_x emissions in an internally air staged burner may be accomplished by applying a detailed understanding of the particle trajectories.

46873 Pulverized coal combustion: Fuel nitrogen mechanisms in the rich post-flame. Bose, A.C. (Univ. of Arizona, Tucson (USA)); Wendt, J.O.L. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The destruction of nitrogenous species in the post-flame of a pulverized coal flame, supported in a 2 kg/h downflow combustor was investigated. The relative importance of homogeneous and heterogeneous mechanisms was quantified. Results of experiments on doped gas, where heterogeneous mechanisms was quantified. Results of experiments on doped gas, where heterogeneous effects are absent, were compared to those from two different coals, namely a Utah Bituminous and a German Brown coal, each burned under a variety of conditions. Additional special experiments in which hydrocarbons were added to the post-flame of a coal run helped elucidate the importance of NO/hydrocarbon reactions in determining both the NO and the HCN profiles. The results were interpreted in the light of detailed kinetic mechanisms taken from the literature, simplified by partial equilibrium assumptions for nitrogenous and hydrocarbon radicals. An expression for the OH equilibrium overshoot was gleaned from the NO profiles in the gas flames. This expression then not only helped predict the HCN profile in the gas flame, but could also predict the NO profiles for all the coal runs. HCN profiles in the far post-flame zone of the coal flames are strongly influenced by the slow release of nitrogen from the coal residue, and this process is of practical importance in the slow conversion of nitrogenous species to N_2. The destruction of nitrogenous species in a pulverized coal post-flame was, therefore, completely homogeneous and, for all conditions and coals tests, could be adequately described by the available gas phase mechanisms, with no adjustment of rate coefficients.

46874 Advanced NO_x reduction processes using -NH and -CN compounds in conjunction with staged air addition. Chen, S.L. (Energy and Environmental Research Corporation, Irvine, CA (USA)); Cole, J.A.; Heap, M.P.; Kramlich, J.C.; McCarthy, J.M.; Pershing, D.W. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989).

DOE Contract AC22-84PC70771. From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The effectiveness of combustion modifications for the control of nitrogen oxide emissions from coal fired combustors is most often limited by problems due to carbon burnout or flame impingement. This paper presents new data on the use of selective reducing agents suggesting that a hybrid control scheme is possible which uses combustion modification to provide those conditions which optimize the selective reduction process. The experimental studies were conducted in a tunnel furnace which simulated the thermal environment within a pulverized coal boiler. Application of each of the agents (ammonia, urea, cyanuric acid, and ammonium sulfate) to an overall fuel lean environment produced NO reduction behavior very similar to that of thermal deNO_x. However, if the agent was added to the fuel rich zone of a rich/lean staged combustor, very high NO reductions were obtained after the leanout point. The result of the staging was to extend the effectiveness of the agent to lower temperatures relative to overall lean injection. Kinetic modeling suggests that the rich zone acts primarily as a source of CO. At the rich/lean transition the CO is oxidized and excess OH is produced by the usual chain branching reactions. For low initial CO concentrations the excess radicals are consumed by: $NH_3 + OH = NH_2 + H_2O$ and $HNCO + H = NH_2 + CO$. The NH_2 is then available for reaction with NO to eventually yield N_2. The strong rich zone stoichiometry dependence is exerted mainly through the amount of CO supplied to the lean zone.

46875 The reduction of NO_x emissions from a fluidized bed combustor by staged combustion combined with ammonia addition. Gibbs, B.M. (Univ. of Leeds (England)); Salam, T.F.; Sibtain, S.F.; Pragnell, R.J.; Gauld, D.W. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The European Economic Community is proposing legislation aimed at limiting NO_x, SO_x and particulate emissions from large combustion plants. The limit values proposed indicate that NO_x emissions from the present generation of atmospheric fluidized bed combustors, burning large coals (6-25 mm) in shallow beds, may need to be reduced by up to 50%. This paper reports on an investigation in which air-staging is combined with gaseous ammonia injection, for the reduction of NO_x emissions. The experimental rig consisted of a stainless steel combustor 2 m high and 0.3 m square in section. Fluidizing air was supplied through a tuyure distributor and secondary air was introduced into the freeboard via an injector whose height could be adjusted. Ammonia was injected over the bed surface. The experiments were carried out at an overall fluidizing velocity of 2 m/s, bed temperature 870 C and 40% excess air. Combustion gases were sampled by probes located at various locations in the combustor and also by a vertical probe that could scan the total length of the combustor. A 50% reduction in NO_x emissions was achieved using 35% air staging combined with ammonia injection at a NH_3/NO mole ratio of 0.6:1. The measured ammonia emissions in the flue gas were less than 20 ppm. Technical issues such as fouling, corrosion, excess ammonia slippage and the costing implications for this technology remain to be addressed on commercial sized fluidized be combustors.

46876 Increased SO_2 removal with the addition of alkali metals and chromium to calcium-based sorbents. Slaughter, D.M. (Energy and Environmental Research Corporation, Irvine, CA (USA)); Chen, S.L.; Seeker, W.R.; Pershing, D.W.; Kirchgessner, D.A. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Injection of calcium-based sorbents is currently being considered as a potential method of reducing SO_2 in existing coal-fired boilers. This study investigated the ability of small concentrations of additives to enhance sulfur capture with calcium-based sorbents. The interaction between the mineral ash (produced from coal combustion) and the sorbent-additive combination was also studied. Two furnace facilities and an x-ray diffractometer were used in the experimental study. The furnaces used included a 300 kW down-fired furnace capable of simulating time and temperature profiles for a variety of boilers, and a bench-scale 18 kW drop-tube furnace. Addition of known promoters with sorbents has effectively increased sulfur capture. Both alkali metals and chromium react with calcium to increase the accessibility of CaO sites by particle fragmentation, creation of large pores, and the presence of a liquid phase. In general, the chromium eliminated by ash interaction was small, while the ash effectively prevented a significant portion of sodium from contacting and reacting with the calcium sorbent.

46877 Evaporation, agglomeration, and explosive boiling characteristics of coal-water fuels under intense heating conditions. Maloney, D.J. (Department of Energy, Morgantown, WV (USA)); Spann, J.F. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The objective was to determine the energy flux (heating rate) requirements for explosive boiling and to evaluate the potential for secondary atomization in practical combustion systems. Single CWF droplets were suspended electrodynamically and irradiated from two sides with well-characterized heating pulses. The dynamic response of the droplets was recorded using high-speed cinematography. Explosive boiling thresholds were measured as a function of CWF droplet size and composition. Heat flux intensities were varied from 0.3 to 10 kW/cm^2 (equivalent heating rates of 10^4 to 10^6 K/s), and heating times were varied from 0.2 to 8.0 ms. A mechanism is proposed which involves elimination of the water-air interface, inhibition of surface evaporation, and the formation of a fused surface layer during the rapid heating process. The energy requirements for explosive boiling were proportional to the mass for droplets with equivalent coal loadings and scaled with the weighted average heat capacity for droplets with equivalent coal loading and scaled with the weighted average heat capacity for droplets with differing composition. The time domain over which explosive boiling was observed spanned from about 2 to 8 ms. For longer times (lower heating intensities) heat losses due to droplet evaporation prevented the internal superheating required for explosive boiling. At shorter times, the required heat fluxes were well beyond practical technological limitations. The energy fluxes required to cause explosive boiling and secondary atomization are on the order of 1 kW/cm^2 for droplets ranging from 75 to 160 μm in diameter (50 percent by mass coal). This may be considered as a target level for advanced combustor designs.

46878 Pre-ignition phenomena and their effects on overall combustion rates of coal slurry droplets. Burgess, A.R. (University College London (England)); Ghaffari, R. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Four coals were used in slurries with water (CWS), methanol (CMS) and a water-methanol mixture (CWMS). Temperatures and combustion times were measured for a range of droplet sizes. Surface agglomeration of fine coal particles and water evaporation are suggested as causes of the microexplosive dispersion of part of a CWS droplet which occurs in the pre-ignition period if the slurry is made from a low swelling coal and if the droplet is larger than a minimum size. During the flame period CMS and CWMS droplets of all sizes are similarly disrupted. Overall combustion times for methanol-containing slurries are shorter than those of CWS. CWS droplets can ignite heterogeneously or, if there is sufficient time for a build-up of coal volatiles, in the gas phase. A critical minimum droplet diameter, d was found for this homogeneous ignition. Estimated activation energies for heterogeneous (<70 kJ/mol) and homogeneous (65-125 kJ/mol) ignition explain a decrease in d with increased furnace temperature. Surface temperatures at the point of heterogeneous ignition were estimated using thermal explosion theories, and compared with those measured at the droplet center. Peak char combustion temperatures and overall combustion times are little affected by the mode of ignition. d defines an observed transition from surface to flame ignition. The transition is described as the result of competition between the two ignition mechanisms and is discussed in terms of necessary droplet temperatures and

the activation energy for each process. An alternative single mechanism is suggested in which surface ignition, perhaps at a hot-spot, causes subsequent ignition of evaporating volatile materials.

46879 (DOE/METC–89/6101) **Proceedings of the sixth annual coal-fueled heat engines and gas stream cleanup systems contractors review meeting.** Bedick, R.C.; Dorchak, T.P.; Rekos, N.F.; Webb, H.A. (eds.). USDOE Morgantown Energy Technology Center, WV (USA). Mar 1989. 544p. Sponsored by U.S. DOE Fossil Energy. (CONF-890353–: 6. annual coal-fueled heat engines and gas stream cleanup systems contractors review meeting, Morgantown, WV (USA), 21-23 Mar 1989). Order Number DE89000952/JAW. Available from NTIS, PC A23/MF A01 - OSTI; GPO Dep.

The Sixth Annual Coal-Fueled Heat Engines and Gas Stream Cleanup Systems Contractors Review Meeting was held March 21 to 23, 1989, at the Sheraton Lakeview Conference Center in Morgantown, West Virginia. This meeting was sponsored and hosted by the Morgantown Energy Technology Center of the US Department of Energy. The overall objective of these programs is to develop the essential technology for private sector commercialization of integrated heat engine and gas stream cleanup systems – systems that can produce power from coal in a cost competitive and environmentally acceptable manner. Over 50 papers and poster presentations were given in six sessions and one informal poster session: process economics and marketing assessments (six papers); gas turbine combustion and performance (five papers); diesel combustion and performance (four papers); diesel wear and component development (four papers); cleanup systems for coal-fueled heat engines (seven papers); support R&D (eight papers); poster presentations (20 presentations). Individual projects are processed separately for the data bases.

46880 (EPRI-GS–6517) **Impacts of cleaning Texas lignite on boiler performance and economics: Final report.** Durant, J.F.; Kwasnik, A.F.; Lexa, G.F. Electric Power Research Inst., Palo Alto, CA (USA); Combustion Engineering, Inc., Windsor, CT (USA). Kreisinger Development Lab. c Aug 1989. 193p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The Electric Power Research Institute (EPRI) is sponsoring a comprehensive test program to assess the merits of coal cleaning for improving power plant performance. As part of this program Combustion Engineering (C-E) conducted a detailed evaluation of the impacts of cleaning on the fireside performance characteristics of the Wilcox lignite burned at TU Electric's Big Brown Steam Electric plant. This evaluation was co-sponsored by Texas Utilities and EPRI. Both run-of-mine and cleaned lignite were characterized during a series of bench-scale analyses and pilot-scale combustion tests. Testing addressed the areas of pulverization, combustion, ash slagging, ash fouling, fly ash erosion, and emissions. Test results were applied using C-E design and performance models to predict operational impacts for a utility boiler switching to the cleaned lignite. Results of this evaluation show that coal cleaning had a beneficial effect on nearly all areas of fuel performance. Both mill wear potential and grinding energy requirements were reduced for the cleaned lignite. Contrary to predictions based on commonly used bench-scale indicators, pilot-scale combustion results showed improved ash slagging and fouling behavior. Fly ash erosion potential decreased significantly due to cleaning. The performance benefits of the cleaned lignite can be translated into operating savings from maintenance costs reductions due primarily to longer component lives, and from improved plant heat rate due mainly to lower pulverizer power consumption and reduced soot blower medium consumption. 33 refs., 47 figs., 39 tabs.

46881 (ORNL/FTR–2842) **[Fluidized bed combustion of high-ash Indian coals]: Foreign trip report, January 5, 1988–March 16, 1988.** Krishnan, R.P.; Daw, C.S. Oak Ridge National Lab., TN (USA). Mar 1988. 67p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. Order Number DE89017396/JAW. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The foreign research assignment at BHEL, Trichy, was undertaken to participate in the ongoing USAID/BHEL joint program in fluidized bed combustion (FBC). As part of this program, an experimental FBC research test facility has been designed, erected and commissioned at BHEL, Trichy, to conduct experiments on the combustion of high-ash Indian coals and coal washery rejects. The data will be used to optimize the design and to select the operational parameters for large scale industrial and utility FBC boilers. ORNL has been providing technical assistance to BHEL since the initiation of the project in November 1983. The US team visited at 10 MW(e) FBC boiler fired with coal washery rejects at the Tata Iron and Steel Company (supplied by BHEL). The tour was very informative and gave the US team a good first-hand perspective of the Indian experience and concerns with FBC technology.

46882 (ORNL/FTR–3151) **[Coal conversion, renewable energy and energy efficiency in India]: Foreign trip report, October 31, 1988–December 8, 1988.** Krishnan, R.P. Oak Ridge National Lab., TN (USA). Dec 1988. 26p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017387/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The US Agency for International Development (USAID) Mission in New Delhi, India, as part of the ongoing Alternative Energy Resources Development (AERD) Project, is initiating follow-on projects related to coal conversion, renewable energy, and energy efficiency. A four-member team was invited to India for three weeks to assist the mission in identifying the activities to be undertaken and the institutional arrangements necessary to successfully complete the activities in the remaining two years of the AERD project. The traveler participated as a member of the team to work on the coal project design issues.

46883 (PB–89-191480/XAB) **Experiments on the combustion of small peat particles in an entrained-flow, isothermal furnace. Research note.** Saastamoinen, J. Valtion Teknillinen Tutkimuskeskus, Jyvaeskylae (Finland). Kotimaisten Polttoaineiden Lab. 1989. 24p. (VTT/RN–947). Available from NTIS, PC EE02/MF A01.

The combustion of pulverized peat was examined in the drop tube furnace by using air as the atmosphere. The results can be used to compare the combustion behavior of peat with that of coal, providing information about the suitable particle size of peat in order to obtain a similar combustion behavior in a furnace, when coal is replaced by peat. The measurement data are also valuable for the modelling work.

46884 Combustion characteristics of dry-coal-powder-fueled adiabatic diesel engine. Kakwani, R.M. (Adiabatics, Inc., Columbus, IN (US)); Kamo, R.; Cutlip, R.G.; Smith, W.C. pp. 74 of Coal-fueled diesel engines. McMillan, M.H. Webb, H.A American Society of Mechanical Engineers, New York, NY (1989). (CONF-8901106–: Coal fueled diesel engines, Houston, TX (USA), 22-25 Jan 1989).

The combustion characteristics of an adiabatic diesel engine, fueled by fumigating micronized coal powder into the intake air, were investigated using a single cylinder test engine. Ignition of the coal powder was facilitated by using an insulated, uncooled precombustion chamber to provide a hot surface for the coal and air mixture to ignite. This ignition system is referred to as the Thermal Ignition combustion System (TICS). The operation of the TICS chamber was enhanced by applying thermal barrier coatings to the engine components in the main combustion chamber and by running the engine without coolant.

46885 Ignition of coal particles. Essenhigh, R.H. (Ohio State Univ., Columbus, OH (USA). Dept. of Mechanical Engineering); Misra, M.K.; Shaw, D.W. *Combustion and Flame (USA),* 77(1): 3-30 (Jul 1989).

This review of ignition concepts and mechanisms is set in the context of the historical development of the subject, to explain the reason for the slow development of validated ignition theory until quite recently, but leading to the present theoretical developments and supporting experiments for ignition of a single particle. The principal focus is on the heterogeneous ignition concepts as these are most fully developed at this time on the basis of Thermal Explosion Theory (TET), but the requirements of a homogeneous ignition analysis are also discussed, with particular attention given to the well known radical mechanism in a generalized formulation. Extension of the single particle results to batch clouds and flames is

examined, with theoretical results for clouds now available but awaiting verification. The problem of a standing flame in a continuous flow is seen as a problem of a different order.

0160 Health and Safety

Refer also to citation(s) 46844, 46855

46886 (ETDE-mf–0702693) **Fires in workings with different dips, and consequences to be drawn for the ventilation systems. Final report.** Berg; Noack. Versuchsgrubengesellschaft m.b.H., Dortmund (Germany, F.R.); Westfaelische Berggewerkschaftskasse, Bochum (Germany, F.R.). Pruefstelle fuer Grubenbewetterung. Sep 1988. 102p. (In German). Order Number DE90702693/JAW. Available from NTIS (US Sales Only), PC A06/MF A01.

The following subjects are discussed: Effects of fires in long-span plastic equipment on fire fighting measures and ventilation in mineworks; effects of point fires on fire fighting measures and ventilation in mineworks; fires in diesel-fuelled trackless vehicles; testing of fire alarms in level and inclined works. Air currents were measured during the fire experiments in order to determine the effects of fires on the mine ventilation systems. (orig./HS).

46887 (PB–89-170732/XAB) **Pneumoconiosis in coal miners and exposure to dust of variable quartz content. Final report, December 1985-May 1988.** Miller, B.G.; Kinnear, A.G. Institute of Occupational Medicine, Edinburgh (UK). Nov 1988. 127p. (TM–88/17). Available from NTIS, PC EE07/MF E07.

In the course of the British National Coal Board's Pneumoconiosis Field Research program, medical officers examining chest radiographs considered that a small number showed unusually rapid progression of pneumoconiotic abnormalities. A case-control study based on these radiographs suggested an association with workplace exposure to dusts containing higher proportions of quartz than had previously been seen in the research, and further investigations were initiated. This report describes the design and execution of a study in which existing radiographs for men at this colliery were subjected to intensive re-examination, with the objective of relating any evidence of radiographic abnormalities to data already held on the individual men's exposures to respirable airborne dust in the coal mine, and on lung function and smoking habits.

46888 (RI–9225) **Causes and control of coal mine bumps.** Bureau of Mines, Pittsburgh, PA (USA). 1988. 35p. Available from US General Accounting Office, PO Box 6015, Gaithersburg, MD 20877.

Coal mine bumps involve the violent, rapid failure of coal and rock around a mine excavation. Deep coal mines with strong roof and floor rocks and high-stress conditions frequently experience face and rib bumps. The bump problem is becoming more severe as mining depth increases, prompting efforts to control high stress in advance of mining. This Bureau of Mines report presents a review of the most widely used methods to detect and distress high-stress zones along coal faces and an investigation of stress-related bump problems and destressing techniques at a cooperating mine. Geotechnical instrumentation and microseismic methods were used to better understand bump occurrences in underground coal mines. Laboratory tests of the drilling-yield method for high-stress detection were conducted to determine the correlation between the volume of cuttings obtained and the magnitude of the applied stress at various confining pressures. A three-dimensional, multiple-seam computer modeling program, MULSIM, was used to evaluate the effectiveness of stress-relief methods.

02 PETROLEUM

0201 Reserves

Refer also to citation(s) 46893, 47252

0202 Geology and Exploration

Refer also to citation(s) 46891, 46893, 46896, 48082

46889 (Juel–2264) **Kinetics and quantitative analysis of the isomerization and aromatization of fossil steroid hydrocarbons within experiments and in naturally matured sample sequences.** Marzi, R. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Chemie 5 - Erdoel und Organische Geochemie; Technische Hochschule Aachen (Germany, F.R.). Feb 1989. 225p. (In German). Order Number DE90702844/JAW. Available from NTIS (US Sales Only), PC A10/MF A01.

Three established maturity dependent biomarker reactions, i.e. sterane isomerization at C-20, hopane isomerization at C-22 and the conversion of C-ring monoaromatic steroids into ABC-ring triaromatic steroids have been investigated in great detail for their kinetics and the quantitative evolution of the compounds involved. This has been done by a number of hydrous pyrolysis experiments, known to mimic natural conditions better than dry pyrolysis. The experimental results have then been combined with data from natural samples. The hydrous pyrolysis experiments were able to induce the investigated biomarker reactions under the influence of temperature and time. The following kinetic data were determined from the experiments: Ea=169 kJ/mol and $A=4.86 \times 10^{8}\ s^{-1}$ for the sterane isomerization, Ea=181,4 kJ/mol and $A=4,85 \times 10^{10}\ s^{-1}$ for the steroid aromatization, and Ea=168 kJ/mol and $A=8.1 \times 10^{8}\ s^{-1}$ for the hopane isomerization. The derived kinetic data obtained this way were used for a model simulation of the reaction progress as a function of the geothermal history in the Michigan Basin. (orig./RB).

46890 **Drilling aspects of the deepest well in California.** Shultz, S.M. (Bechtel Petroleum Operations, Inc. (US)); Schultz, K.L.; Pageman, R.C. vp of Proceedings of the SPE California regional meeting. Society of Petroleum Engineers, Richardson, TX (1989). (CONF-890495–: Society of Petroleum Engineers (SPE) California regional meeting, Bakersfield, CA (USA), 5-6 Apr 1989).

Technical Paper SPE 18790.

On May 30, 1985, an Exploratory Well 934-29R was spudded in the Elk Hills Naval Petroleum Reserve #1 at Tupman, California. Bechtel Petroleum Operations, Inc. and the Department of Energy cooperated in a joint effort to drill a 25,000 foot well and determine whether or not hydrocarbons are present at the deeper depths. Several zones of interest had been drilled through when the well reached a final T.C. of 24,426 feet. This paper reveals some of the more significant drilling technology used and also problems encountered while drilling the deepest well in California.

0203 Drilling and Production

Refer also to citation(s) 46920

46891 (NIPER–272) **MEOR [microbial enhanced oil recovery] data base and evaluation of reservoir characteristics for MEOR projects.** Bryant, R.S. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Sep 1989. 18p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC22-83FE60149. Order Number DE89000764/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

One aspect of NIPER's microbial enhanced oil recovery (MEOR) research program has been focused on obtaining all available information regarding the use of microorganisms in enhanced oil recovery field projects. The data have been evaluated in order to construct a data base of MEOR field projects. The data base has been used in this report to present a list of revised reservoir screening criteria for MEOR field processes. This list is by no means complete; however, until more information is available from ongoing field tests, it represents the best available data to date. The data base has been studied in this report in order to determine any significant reports from MEOR field projects where the microbial treatment was unsuccessful. Such information could indicate limitations of MEOR processes. The types of reservoir information sought from these projects that could be limitations of microorganisms include reservoir permeability, salinity, temperature, and high concentrations of minerals in the rock such as selenium, arsenic, or mercury. Unfortunately, most of the MEOR field projects to date have not reported this type of information; thus we still cannot assess field limitations until more projects report these data. 7 refs., 1 fig., 7 tabs.

46892 (NIPER–308) **Laboratory study of nitrogen miscible displacement of light oil.** Llave, F.M.; Hudgins, D.; Chung, F.T.H. National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Sep 1989. 34p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC22-83FE60149. Order Number DE89000762/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Systematic slim-tube displacement tests and coreflooding tests were performed to determine displacement mechanisms and the minimum miscibility pressure (MMP) for nitrogen with light oils. Emphasis of the study was on the injection of a slug of solution gas before. The effect of slug size and composition on the MMP was also studied. Candidate oils from Alaskan reservoirs (26° and 48° API) were also tested for the applicability of nitrogen miscible displacement and the slug injection technique. A series of nitrogen displacement experiments was performed on one of Alaskan oils at varying gas-oil-ratios (GOR) to determine the effect of the intermediate components (C_2-C_5) of the oil on the MMP. A correlation for the MMP has also been developed from literature data on pure nitrogen displacement and data obtained from this work. The proposed correlation shows good agreement with the prediction of the MMP of 14 oils tested. More realistic tests for the nitrogen miscible displacement method were performed in a 2-in. diameter, 2-ft long Berea sandstone core to investigate the effects of gravity segregation and mobility ratio on the recovery efficiency. Secondary and tertiary nitrogen injection tests as well as an initial evaluation of foam flooding as an improvement to nitrogen displacement were also performed. 10 refs., 7 figs., 3 tabs.

46893 (NIPER–400) **[National Institute for Petroleum and Energy Research] 1988 annual report.** National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA). Sep 1989. 515p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FC22-83FE60149. Order Number DE89000759/JAW. Available from NTIS, PC A21/MF A01 - OSTI; GPO Dep.

The following research programs from NIPER are described: jet fuel stability, entrainers in carbon dioxide floods, differential scanning calorimetry simulation of crosslinking in a chemical flood, analytical methods reservoir characterization, strategic petroleum reserve support, microbial EOR, marine diesel fuel requirements, oil mining, hydrodenitrogenation of indole and petrographic image analysis. Individual projects are processed separately for the data bases. (CBS)

46894 A laboratory investigation of foam flow in sandstone at elevated pressure. Persoff, P. (Lawrence Berkeley Lab., CA (US)); Pruess, K.; Benson, S.M.; Radke, C.J.; Witherspoon, P.A. vp of Proceedings of the SPE California regional meeting. Society of Petroleum Engineers, Richardson, TX (1989). (CONF-890495–: Society of Petroleum Engineers (SPE) California regional meeting, Bakersfield, CA (USA), 5-6 Apr 1989).

Technical Paper SPE 18781.

The authors find that foam in the unsteady state is rheopectic; in the steady state it is shear thinning with respect to increasing gas flow but Newtonian with respect to increasing liquid flow. That is, steady pressure gradients for foam are sensibly independent of gas velocity but increase nearly linearly with increasing liquid velocity. No hysteresis in foam flow resistance is noted. Also at steady state, the pressure profile is linear and the liquid saturation is uniform and constant between 30 and 35%, a value that is about 10 saturation units above connate. The steady-state liquid saturation is practically independent of flow rate and inlet foam quality. Hence, foam flow resistance is not a unique function of liquid saturation.

46895 Steam-zone electrical characteristics for geodiagnostic evaluation of steamflood performance. Mansure, A.J. (Sandia National Labs. (US)); Meldau, R.F. vp of Proceedings of the SPE California regional meeting. Society of Petroleum Engineers, Richardson, TX (1989). (CONF-890495–: Society of Petroleum Engineers (SPE) California regional meeting, Bakersfield, CA (USA), 5-6 Apr 1989).

Technical Paper SPE 18797.

An essential part of the development of electrical geodiagnostic techniques for mapping thermal recovery processes is understanding the relationship of formation resistivity to the thermal recovery process. As a result of laboratory measurements of a one-dimensional steamflood, a preliminary understanding of some of the mechanisms of the electrical resistivity change has been gained. The theory of electrical resistivity of a steamflood is reviewed and used to evaluate the resistivity changes expected. A conceptual electrical model of a steamflooded porous reservoir is presented.

46896 Fracture characteristics and reservoir behavior of stress-sensitive fracture systems in flat-lying lenticular formations. Lorenz, J.C. (Sandia National Labs. (US)); Warpinski, N.R.; Sattler, A.R.; Branagan, P.T. *Journal of Petroleum Technology (USA),* 41(6): 615-622 (Jun 1989).

A model is presented that suggests that regional fracture systems commonly control permeability in flat-lying reservoirs. Such fractures are distributed in a continuum of sizes and occur in subparallel, en echelon patterns. Few high-angle, orthogonal fractures exist because this system is created by high pore pressures and relatively low differential horizontal (tectonic) stresses rather than by significant structural deformation. Interfracture communication occurs primarily at infrequent, low-angle intersections of fractures. Vertical continuity of such fractures through a reservoir commonly is limited to the numerous lithologic discontinuities inherent in nonmarine sandstones. This type of fracture system has been documented in Mesaverede rocks in the Rulison field of the Piceance Creek basin, northwestern Colorado, by studies of 4,300 ft [1310 m] of core from the U.S. DOE's three Multiwell Experiment (MWX) wells and by studies of the excellent nearby outcrops. Well test results and geologic data from core and outcrop support the model. The described natural fracture system has a significant effect on production and stimulation.

46897 Density profiles of a draining foam by nuclear magnetic resonance imaging. Assink, R.A. (Sandia Labs., Albuquerque, NM (USA)); Caprihan, A.; Fukushima, E. *A.I.Ch.E. Journal (American Institute of Chemical Engineers) (USA),* 34(12): 2077-2079 (Dec 1988).

Aqueous foams are used as drilling fluids in the petroleum industry and as fire fighting agents. In many applications, the effectiveness of a foam is related to its stability. A common method of characterizing stability is to measure the flow of liquid from the foam as a function of time. Foam drainage has recently been the subject of a detailed theoretical analysis. In addition to predicting the drainage rate, the analysis modeled the density profile of the foam as a function of time. Such profiles are expected to be a fundamental measure of a draining foam's structure as well as a sensitive test of the theoretical drainage models. In this communication, the authors describe initial efforts to measure the density profiles of a draining foam by nuclear magnetic resonance imaging (NMRI) techniques.

0204 Processing

46898 (DOE/PC/80502–T14) **Interactive chemistry of coal-petroleum processing: Quarterly report, March 16, 1989–June 15, 1989.** Curtis, C.W.; Guin, J.A.; Tarrer, A.R. Auburn Univ., AL (USA). Dept. of Chemical Engineering. 1989. 49p. Sponsored by U.S. DOE Fossil Energy. DOE Contract FG22-85PC80502. Order Number DE89016748/JAW. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

For this study, the interactive thermal and catalytic chemistry involved in coprocessing of coal and petroleum has been investigated using model systems representative of those present in coal and residuum in order to gain insight into the chemistry involved in thermal and catalytic coprocessing. The hydrogenation catalyst precursor chosen for this study was molybdenum naphthenate. The active catalytic species were generated in situ in the presence of excess elemental sulfur. The present report gives the results of the reactions of the model compounds of dibenzofuran, dibenzothiophene, fluorene, and carbazole under thermal catalytic reaction conditions by using molybdenum naphthenate in the presence of excess sulfur as the hydrogenation catalyst. The reaction pathways for the hydrogenation and heteroatom removal of the selected model compounds have been investigated. On the basis of experimental results, possible hydrogenation reaction pathways for the different model systems are proposed in this quarterly report. 14 refs., 4 figs., 24 tabs.

0205 Products and By-products

Refer also to citation(s) 46893

0206 Health and Safety

Refer also to citation(s) 47656

0207 Marketing and Economics

Refer also to citation(s) 47253

0209 Environmental Aspects

Refer also to citation(s) 48082, 48083

46899 (PB–89-159727/XAB) **Outer Continental Shelf environmental assessment program. Final reports of principal investigators. Volume 58.** National Ocean Service, Anchorage, AK (USA). Ocean Assessments Div. Dec 1988. 445p. Available from NTIS, PC A19/MF A01.

See also PB–89-159735, PB–89-159743 and PB–89-123616.

Contents include: evaluation of environmental information for the Unimak Pass Area, Alaska; Uukon Delta coastal processes study.

46900 (PB–89-188510/XAB) **Fate and transport of petroleum released from leaking underground-storage tanks in areas of karst topography. Technical report.** Compton, E. University of Southern California, Los Angeles, CA (USA). School of Public Administration. 1988. 43p. Available from NTIS, PC A03/MF A01.

Portions of this document are not fully legible.

This study determines the transport and ultimate fate of petroleum products within a region of karst geomorphology. The paper entails a complete literature review, including references that pertain to contaminant transport within karst aquifers and the remediation of hydrocarbon spills. Rapid dispersal of contaminants within cavernous karstic terrain demands prevention as the only solution, in addition to the recommended technological advances for optimal cleanup of leaking underground storage tanks. Because numerous and widespread service stations have hydrocarbon storage tanks, the contamination problem is considered a nonpoint source of pollution. Stricter standards must be imposed for regulating underground storage tanks that overly karst. Preventative measures to improve inventory control, leak detection, and upgraded tank specifications (rather than corrective actions) are necessary to protect the quality of drinking water provided by carbonate aquifers. Arkansas, louisiana, New Mexico, Oklahoma, and Texas (the five states forming U.S. EPA Region VI) constitute the designated study area. With the exception of Louisiana, each state within the region has considerably large, karst aquifers.

0230 Properties

Refer also to citation(s) 46836, 46889, 47308

0250 Combustion

Refer also to citation(s) 47470, 47561, 47566, 47567, 47568, 47569, 47570, 47598, 47602, 47616, 47617, 47642, 47669, 47953

46901 (AD-A–207372/4/XAB) **Hot-surface ignition tests of aircraft fluids. Final report, May 1987-May 1988.** Johnson, A.M.; Roth, A.J.; Moussa, N.A. Boeing Advanced Systems Co., Seattle, WA (USA). Nov 1988. 239p. Available from NTIS, PC A11/MF A01.

Five fluids commonly found in aircraft-engine components, JP-4 and JP-8 fuels, Mil-H-5606 and Mil-H-83282 hydraulic fluids and Mil-L-7808 lubricating oil, were tested in the Aircraft Engine Nacelle Fire Test simulator (AENFTS) to define their Minimum Hot Surface Ignition Temperature (MHSIT's) when introduced as a spray or stream onto a hot engine bleed duct. The test employed a simple, uncluttered test section and a realistically simulated portion of the F-16 engine compartment. MHSIT's for all but Mil-H-83282 were consistently found to be higher than the fluids autoignition temperature.

46902 **Combustion efficiency, radiation, CO and soot yield from a variety of gaseous, liquid, and solid fueled buoyant diffusion flames.** McCaffrey, B.J. (National Bureau of Standards, Gaithersburg, MD (USA)); Harkleroad, M. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The following compilation of data describes combustion conditions for the free burning of propane, heptane, 3 crude oils, wood and polyurethane cribs in fuel package sizes less than a meter, having heat release rates up to 1/2 MW. Measurements include heat release rate from O_2 depletion calorimetry, mass loss rate, incident radiative flux to nearby targets, flame and liquid interface temperatures and overall major gaseous species yield including soot. The information contained herein provides a data base for buoyant diffusion flame modelling regarding radiation and elementary chemical characterization. There appears to be a one-to-one correspondence between a fuels radiative behavior and its soot and CO yield. Urethanes and crude oil have significantly higher values for all these parameters as compared to propane, heptane and wood. No correlation was found between these measurements and time-averaged thermocouple reading of temperature.

46903 (N–89-21051) **Fuel-rich catalytic combustion of Jet-A fuel-equivalence ratios 5.0 to 8.0.** Brabbs, T.A.; Gracia-Salcedo, C.M. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. May 1989. 10p. (NASA-TM–101975;E–4675;AVSCOM-TR–89-C-001;NAS–1.15:101975;CONF-890446–: Combustion Institute spring meeting: combustion fundamentals and applications, Dearborn, MI (USA), 30 Apr - 3 may 1989). Available from NTIS, PC A02/MF A01.

Fuel-rich catalytic combustion (E.R. greater than 5.0) is a unique technique for preheating a hydrocarbon fuel to temperatures much higher than those obtained by conventional heat exchangers. In addition to producing very reactive molecules, the process upgrades the structure of the fuel by the formation of hydrogen and smaller hydrocarbons and produces a cleaner burning fuel by removing some of the fuel carbon from the soot formation chain. With fuel-rich catalytic combustion as the first stage of a two stage combustion system, enhanced fuel properties can be utilized by both high speed engines, where time for ignition and complete combustion is limited, and engines where emission of thermal NO sub x is critical. Two-stage combustion (rich-lean) has been shown to be effective for NO sub x reduction in stationary burners where residence times are long enough to burn-up the soot formed in the first stage. Such residence times are not available in aircraft engines. Thus, the soot-free nature of the present process is critical for high speed engines. The successful application of fuel-rich catalytic combustion to Jet-A, a multicomponent fuel used in gas turbine combustors, is discusssed.

03 NATURAL GAS

46904 (PB–89-195812/XAB) **Gas Research Institute 1988 annual report. Benefits, balance, broad industry cooperation.** Gas Research Inst., Chicago, IL (USA). Apr 1989. 60p. (GRI–89/0119). Available from NTIS, PC A04/MF A01.

See also PB–88-141569. Color illustrations reproduced in black and white.

With a theme of 'Benefits, Balance, and Broad Industry Cooperation,' the Gas Research Institute (GRI) 1988 Annual Report includes a message from the chairman and president; financial highlights, report and notes; and lists of the Board of Directors, management, member companies, advisory bodies and 1988 R&D contractors. A special report describes GRI-sponsored technologies that entered the marketplace in 1988. Feature stories discuss R&D activities in these six broad areas of current high interest: pipeline operations, residential and commercial cooling, natural gas supply, distribution operations, industrial processes and cogeneration, and pollution control.

0302 Geology and Exploration

Refer also to citation(s) 48082

46905 (DOE/MC/20422–2729) **FY 1988 USGS [US Geological Survey] annual report.** Law, B.E. Geological Survey, Denver, CO (USA). Jun 1989. 40p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AI21-83MC20422. Order Number DE89011682/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

As a result of the large area and great thickness of gas-bearing reservoirs in the Greater Green River basin, many of our investigations have focused on single wells or small areas containing several wells where a large amount of data is available, The investigations include structure, stratigraphy, petrography, x-ray mineralogy, source-rock evaluation, formation pressure and temperature, borehole geophysics, thermal maturity mapping, fission-trace age dating, fluid inclusion thermometry, and isotopic geochemistry. The objectives of these focused investigations are to provide geologic models that can be compared and utilized in tight gas-bearing sequences elsewhere. The purpose of this report is to summarize the tight gas reservoir research activity of USGS geoscientists during FY 88. During the reporting period, most of our efforts were focused on the assessment of gas resources in low-permeability sandstone reservoirs in the Greater Green River basin. Other significant activities included a reservoir study of the Upper Cretaceous Almond Formation in the Greater Green River basin, a fracture study of Cretaceous and Tertiary outcrops in the Washakie basin, and a stratigraphic study of lower Tertiary rocks in the Washakie basin and Rock Springs uplift. 58 refs., 9 figs., 5 tabs.

46906 (PB–89-190896/XAB) **Devonian shale-specific computation methodology. Topical report, June 1988.** Guidry, F.K.; Truman, R.B.; Campbell, R.L.; Harrison, C.W. ResTech Houston, Inc., TX (USA). Jun 1988. 48p. Available from NTIS, PC A03/MF A01.

This report presents the application of the 'Devonian Shale-specific Formation Evaluation Model' for the evaluation of geophysical well logs in the Devonian shale. A procedure is outlined for determining lithology, porosity, and bulk volume free-hydrocarbon. The logging suite commonly utilized by ResTech for evaluation of the shales is presented. However, methods were developed for obtaining reliable results in certain areas with a reduced logging suite. The final report from an analysis includes a written document containing recommended completion intervals and perforations. Also included within the report are the results presented in both a log and listed format. The log format has an 11-inch and 22-inch presentation. In addition to lithology, porosity, and bulk-volume free-hydrocarbon that are presented on the 11-inch presentation, results from the borehole television, temperature survey, and mudlog are displayed on the 22-inch wide presentation.

0303 Drilling, Production, and Processing

Refer also to citation(s) 46894

0306 Marketing and Economics

Refer also to citation(s) 47255

46907 (PB–89-181127/XAB) **Advanced-technology gas-fired commercial clothes dryer. Final report, April 1985-December 1988.** Topping, R.F. Little (Arthur D.), Inc., Cambridge, MA (USA). Mar 1989. 68p. Available from NTIS, PC A04/MF A01.

The objective of this project was to demonstrate the technical feasibility of an advanced-technology commercial clothes dryer which could provide improved fuel efficiency and reduced drying time. These improvements will benefit coin laundries by making their operations more profitable and consumers by reducing the time and the cost of doing laundry tasks. The most-significant result of this effort was the demonstration of an advanced technology dryer concept. This unit demonstrated a large increase in fuel efficiency over the current population of dryers with no adverse effect on other performance parameters. In addition to demonstrating the concept feasibility, a computer model of the drying process was developed and validated against test data. The model was used to provide an understanding of the parameters that influence the drying process and their relative importance. The model then was used to evaluate a variety of design concepts. Also, through in-store surveys and other means, information was gathered on machine use in laundries which was used to refine the design specifications. A new capability, automatic lint disposal, was found to offer significant operational benefits and was therefore included in the prototype demonstration. Field testing by the manufacturing partner is preceding commercialization with staged introduction of the advanced features planned.

46908 (PB–89-194013/XAB) **Assessment of the effect on the gas industry of the National Appliance Energy Conservation Act of 1987. Topical report, November 1988.** Liljenberg, G.W. American Gas Association Labs., Cleveland, OH (USA). 28 Nov 1988. 161p. Available from NTIS, PC A08/MF A01.

This report evaluates the effect on the appliance industry, the utility industry, and the consumer of the National Appliance Energy Conservation Act of 1987 (NAECA). The Act affects residential appliances. Existing state efficiency standards are preempted. Most residential gas-fired appliances are affected by NAECA efficiency standards. Most severely affected (high percentage of models that do not meet efficiency standards) are horizontal warm-air furnaces and lo-boy water heaters. Both types of appliances are used primarily in warmer climates where slab and crawl space type homes are constructed. Increasing the efficiency of appliances will typically increase the initial cost to the consumer. Payback time is increasingly important as the annual climate becomes warmer. The warmer the annual climate, the longer the payback time. It is recommended that research begin immediately to develop low-cost appliances that meet NAECA efficiency standards; manufacturers who may need research help to develop higher efficiency appliances be identified; and venting needs of appliances meeting NAECA efficiency standards be studied.

46909 (PB–89-204085/XAB) **Gas Research Institute: an update, January 1989.** Gas Research Inst., Chicago, IL (USA). Jan 1989. 15p. (GRI–89/0131). Available from NTIS, PC A03/MF A01.

See also PB–88-129945.

GRI's planning process, funding, operations, membership, and formal review mechanism are described. R and D activities discussed include: new products in the marketplace; technology for residential customers; R and D aimed at commercial building markets; research for improving gas-fueled processes and technologies for industry; environmental concerns; and increasing economical gas supplies. A list of member company field test partners is included.

46910 (PB–89-205090/XAB) **Gas Research Institute: overview, January 1989.** Gas Research Inst., Chicago, IL (USA). Jan 1989. 12p. (GRI–89/0095). Available from NTIS, PC A03/MF A01.

See also PB–88-129937.

GRI's R and D program, membership, and funding (including coordinated funding) are reviewed. Congressional support for gas-related research is discussed. GRI is addressing environmental concerns through research in areas such as compressed natural gas technology and clean-coal technologies. Activities aimed at increasing economical gas supplies include projects in secondary gas recovery and a series of staged field experiments. R and D aimed at residential and commercial markets includes the Laboratory Smart House and the development of new technologies in desiccant cooling systems and gas heat pumps. The GRI 1989 R and D Budget Allocation Summary is included.

0307 Waste Management

Refer also to citation(s) 46915

0308 Environmental Aspects

Refer also to citation(s) 46899, 48082, 48083

46911 (PB–89-173611/XAB) **Water-spray barriers for LNG (liquefied natural gas) vapor mitigation. Topical report, September 1987-November 1988.** Atallah, S.; Guzman, E.; Shah, J. Risk and Industrial Safety Consultants, Inc., Des Plaines, IL (USA). Nov 1988. 53p. (REPT–4015.1). Available from NTIS, PC A04/MF A01.

A review of previous studies has shown that, if properly designed and installed, water-spray barriers may be used as a means for the dispersion of liquid natural gas (LNG) vapor clouds. This report is

one of a series documenting the performance of LNG hazard prevention and mitigation technologies for LNG storage facilities. Design and cost considerations explored here will be employed in a final project report, which will formally address cost-effectiveness of these various options as a function of installed and operating costs and reduction of public risk to large-scale LNG spill and vapor-dispersion hazards.

46912 (PB–89-186027/XAB) **Emissions data for stationary reciprocating natural gas engines and gas turbines in use by the gas-pipeline-transmission industry (for microcomputers). Data file.** Martin, N.L.; Thring, R.H. Southwest Research Inst., San Antonio, TX (USA). Feb 1989. vp. Available from NTISCP D03.

The data file is contained on 5 1/4-inch diskettes, high density (1.2M), compatible with the IBM PC/XT/AT microcomputer. The diskettes are in the ASCII format. Price includes documentation, PB–89-186035.

The emissions data base and report program for stationary reciprocating natural gas engines and gas turbines is contained on four 1.2-megabyte diskettes and is accompanied by a user's manual. The data base contains both emissions and performance data taken from in-service natural gas engines in use by the gas pipeline transmission industry. The software is designed to be operated on an IBM or compatible personal computer and must be run in a directory containing th dBase III+ programs and the Quickcode utility program. The user's manual describes the inputs to and outputs from the data base update and report program, EMIMAIN. EMIMAIN is an interactive dBase III+ command routine which displays a series of menus to the user and allows one to either update the data bases or print reports containing data from the data bases. In order to use the software on the diskette, dBase III+ and Quickcode software packages must be purchased.

0309 Artificial Stimulation

46913 (PB–89-181135/XAB) **Three-dimensional hydraulic fracture model development for application to and understanding of coal-bed methane-stimulation treatments. Final report, July 1, 1984-December 16, 1988.** Mavko, B.B.; Nielsen, P.E.; Hanson, M.E. Comdisco Resources, Inc., San Francisco, CA (USA). 1 Mar 1989. 139p. Available from NTIS, PC A07/MF A01.

A preliminary three-dimensional numerical model was developed to simulate hydraulically driven fracturing for application to coal seam methane drainage. The initial focus was development of a circular fracture model which served, in part, as a test bed for concepts and formulations applicable to the more general three-dimensional model. Findings from circular model studies were used to design a multiseam fracture treatment. The three-dimensional model involved development of exact influence coefficients for the elastic calculations, inclusion of the aperture time derivative, implementation of an equilibrium tip condition, incorporation of modulus and stress layering, dynamic grid rezoning, incorporation of a two-dimensional fluid flow solution, implementation of the applicable fluid flow boundary conditions, development of a physically realistic fracture front propagation scheme, and proper coupling and control of the various fracture, flow, and calculational model components. Model simulations illustrate important physical effects of fracturing in coal. Preliminary simulations are discussed which show the effects of different viscosity fluids, and effects of stress and modulus variations on vertical fracture containment.

0310 Legislation and Regulation

46914 (NPA–BT31-1990-III-31) **Northern Pipeline Agency Canada, 1989-90 estimates. Part 3, expenditure plan.** Northern Pipeline Agency, Ottawa, ON (Canada). 1989. 38p. (In English and French). (MICROLOG–89-03616). Available from Northern Pipeline Agency, Lester B. Pearson Building, 125 Sussex Drive, Ottawa, ON, CAN K1A 0G2; $3.00; OTHER COUNTRIES: $3.60 CAN; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1; $10 CAN.

The Northern Pipeline Agency was established to facilitate the efficient and expeditious planning and construction of the Alaska Highway Gas Pipeline in a manner consistent with tthe best interests of Canada as defined in the Northern Pipeline Act. This document presents an overview of the Agency's programs, highlights of plans and recent performance, and a profile of program resources. Detailed budgets for various parts of the program are included. 3 figs., 5 tabs.

0340 Combustion

Refer also to citation(s) 46907, 47318, 47407, 47567, 47570, 47576, 47584, 47585, 47592, 47597, 47603, 47604, 47605, 47613, 47614, 47620, 47667, 47674, 47676, 47684, 47685, 47952

46915 Reduction of NO_x emission in turbulent combustion by fuel-staging/effects of mixing and stoichiometry in the reduction zone. Kolb, T. (Universitaet Karlsruhe (West Germany)); Jansohn, P.; Leuckel, W. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A fuel-staged combustion system is optimized for minimum NO_x emission by systematic variation of the fuel/air equivalence ratio (ER) and the exit momentum of the reburn-fuel jets in the reduction zone. The fuel is natural gas (NG) doped with 3 Vol% ammonia (NH_3). The ER in the secondary fuel-rich reduction zone is varied between $1.04 \leq \phi_2 \leq 1.22$. Dilution of the reburn-fuel with nitrogen (N_2) allows a variation of the momentum of the radially injected reburn-fuel jets at constant stoichiometry to study the influence of mixing in the reduction zone on NO_x emission. Concentrations of NO, NO_x, HCN, NH_3 and of the stable species of the C-H-O-system are measured after the reduction and after the burnout zone, respectively. Detailed information about the conversion and reduction of N-species in the reduction zone for two different mixing conditions is obtained from local concentration measurements of the above mentioned species in the reduction zone. The experiments show that variation of ER in the reduction zone leads to a NO_x emission minimum for $\phi_2 = 1.15$. For an equivalence ration ϕ_2 close to the optimum value improved mixing in the reduction zone results in a reduced N-species concentration (NO, HCN, NH_3) after the reduction zone and thus a lower NO_x emission of the total system. Finally a simplified model is evaluated to calculate the penetration and the mixing length of the reburn-fuel jets.

46916 Spark ignition of methane and methanol in ozonized air. Nomaguchi, T. (Univ. of Tokyo (Japan)); Koda, S. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Spark ignition experiments using constant voltage and constant current pulses were performed in a closed vessel at reduced pressure for premixed methane and methanol mixtures with partially ozonized air. Minimum pulse durations for successful ignition were determined for various equivalence ratios and ozone contents. The pulse duration could be shortened considerably by adding small amounts of ozone to both fuels, particularly to methane. The effects were clearly observed with a 0.2% ozone fraction of oxygen in the ozonized air. The burning velocity of premixed methane/air at room temperature and atmospheric pressure was also measured and found to be increased somewhat in the presence of ozone. Kinetic model calculations for the ignition process of methane and methanol mixtures with ozonized air were carried out numerically at given elevated temperatures. The ignition delay times obtained reproduced the trends found in the experimentally determined minimum pulse durations. Inspection of the calculated evolution of species concentrations indicates that the acceleration effect is caused by the production of oxygen atoms which attack parent fuels to induce radical chain reactions. Thus ozonized air may be useful for improving the ignitability of various fuel mixtures.

46917 (PB–89-194112/XAB) **Reports published by the Gas Research Institute in the area of residential/commercial appliances and space conditioning: bibliography and abstracts. Update through 1988.** Murphy, M.J.; Locklin, D.W.; Johnson, O.D. Battelle Columbus Div., OH (USA). 25 Apr 1989. 81p. Available from NTIS, PC A05/MF A01.

See also PB–88-191028.

The updated bibliography contains citations of reports published by the Gas Research Institute pertaining to residential and commercial gas appliances and space-conditioning equipment. It does not include heat pumps or cogeneration. The reports are listed in order of GRI number and are indexed by subject, author, and GRI report number. Report citations include abstracts taken from the NTIS database. The updated bibliography was compiled and indexed from the Gas Appliance Technology Center InfoBase, an electronic data base of evaluated references in the area of gas appliance technology.

46918 (PB–89-195069/XAB) **Basic research on natural gas combustion phenomena. Annual report, September 1987-August 1988.** Frenklach, M.; Gardiner, W.C. Pennsylvania State Univ., University Park, PA (USA). Davey Lab. 15 Sep 1988. 70p. Available from NTIS, PC A04/MF A01.

See also PB–88-168380.

This research developed a universal chemical kinetic model for the combustion and ignition of methane (and mixtures of methane with other gases mimicking the composition of natural gas) in terms of elementary chemical reactions with rates specified as functions of temperature and pressure. During the past year, kinetic absorption spectroscopy of OH was used to take data on the H_2-O_2 reaction subset of the natural gas combustion mechanism, unimolecular reaction falloff corrections were incorporated into the model programs, methods were developed for efficient interpolation between high- and low-pressure limiting rate constants, and an intensive study into the underlying reasons for the frequency and amplitude instabilities in the frequency-doubled cw dye laser were made. A number of manuscripts were written, submitted for publication, and presented at national and international meetings.

46919 (PB–89-195770/XAB) **Advanced indirect gas-fired heating system. Final report, August 15, 1984-June 30, 1988. Phase 2: Development. Phase 3: Application.** Watson, J.; Bowers, J. North American Mfg. Co., Cleveland, OH (USA). Jan 1989. 35p. Available from NTIS, PC A03/MF A01.

In Phase II a gas-fired high-temperature regenerative radiant-tube burner system with a 'W' shaped radiant tube was developed. Phase III successfully applied that system to the Surface Combustion, Inc. 'Ultracase' furnace resulting in higher furnace temperatures, heating rates, and higher efficiencies than conventional gas-fired furnaces.

04 OIL SHALES AND TAR SANDS

0403 Drilling, Fracturing, and Mining

Refer also to citation(s) 46893

0405 Properties and Composition

46920 (Juel–2262) **Characterization of sorbed oil components on clays and quartz grains in oil sand. A contribution to the wettability of reservoir rocks in petroleum deposits.** Fendel, A. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Chemie 5 - Erdoel und Organische Geochemie; Technische Hochschule Aachen (Germany, F.R.). Feb 1989. 214p. (In German). Order Number DE90702841/JAW. Available from NTIS (US Sales Only), PC A10/MF A01.

The wettability of an oil reservoir strongly influences the recovery rate during primary production and the feasibility of Enhanced Oil Recovery. In order to achieve an insight into the chemical nature of the oil components sorbed onto mineral surfaces, unconsolidated Canadian (Athabasca, Cold Lake) and U.S. oilsands (Tar Sand Triangle) were exhaustively extracted with dichloromethane by Soxhlet to remove the non-sorbed, so called free oil. The sorbed oil on the clays were investigated in situ by spectroscopy and pyrolysis. Clays and quartz were extensively extracted with polar solvent mixtures to release the sorbed oil. The extractable sorbed oil and the corresponding free oil were fractionated in chemically defined compound classes by adsorption chromatography. The fractions were characterized by means of GC, GC//MS and IR-spectroscopy. The sorbed oil is highly enriched in oxygen functions bearing components, which partly show a polyfunctional character. The surprising existence of n-alkanes in the sorbed oil, which are not detected in the free oil, is explained by occlusion in the sorbed organic layer. The existence of sterols could be shown in the free and the sorbed oil though not being reported in literature to date. Clays and quartz show a different behavior of sorption. Opposite to the general accepted idea, of smectites showing the highest capacity to sorb organics, the highest amount of sorbed oil was found in the kaolinite-/illite-rich samples. Different mechanisms of oil sorption onto the mineral surfaces, possibly driven by entropy, are discussed. (orig./RB).

0406 Direct Uses and By-products

46921 (ORNL/FTR–2801) **[Combustion tests of sample Jordan oil shale, Karhula, Finland, and visit to Espoo, Finland, January 14–20, 1988]: Foreign trip report.** Holcomb, R.S. Oak Ridge National Lab., TN (USA). 4 Feb 1988. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017424/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler was present at combustion tests of sample Jordan oil shale in the Ahlstrom CFB test unit during which a series of tests was run to determine the effect of the key operating parameters on the combustion performance. A tour was given of the 80 MWt CFB coal-fired district heating boiler plant in Espoo, Finland. Both activities provided valuable insight for the technical evaluation.

0407 Health and Safety

46922 **Behavior of combustible liquid soaked in porous beds during flame spread.** Takeno, Keiji (Univ. of Tokyo (Japan)); Hirano, Toshisuke. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

An experimental study has been performed in order to elucidate the dependence of flame spread on the behavior of combustible liquid soaked in the layer of close-packed beads during flame spread across its surface. The movement and distribution of the combustible liquid in the layer have been explored by using colored liquid tracer techniques and hot wire anemometry. Also, the dependence of the bead diameter, liquid viscosity, and volatile component added to the liquid on the flame spread phenomena have been examined in detail. When the combustible liquid was a mixture of 90 vol % decane and 10 vol % hexane and filled to be flush with the bead layer surface, or when it was decane and its initial level was 0.5 cm below the bead layer surface, the flame spread rate V_f was found to depend scarcely on the liquid viscosity μ or bead diameter d. To the contrary, when the combustible liquid was decane and filled to be flush with the bead layer surface, V_f depended significantly on d and μ. The layer where the combustible liquid adhered to bead surface in the process of evaporation was observed beneath the leading flame edge. Based on these experimental results, the dominant mode of heat transfer was inferred to be conduction through the dry and liquid-gas coexisting regions. it was pointed out that the flame spread phenomena for large bead diameters would be controlled by liquid movement in the porous bed.

0409 Waste Research and Management

46923 (DOE/MC/24092–2725) **Eastern oil shale research involving the generation of retorted and combusted oil shale solid waste, shale oil collection, and process stream sampling and characterization: Final report.** Synfuels Engineering and Development, Inc., Rifle, CO (USA). Feb 1989. 92p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-88MC24092. Order Number DE89011694/JAW. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

Approximately 518 tons of New Albany oil shale were obtained from the McRae quarry in Clark County, Indiana and shipped to Golden, CO. A portion of the material was processed through a TOSCO II pilot plant retort. About 273 tons of crushed raw shale, 136 tons of retorted shale, 1500 gallons of shale oil, and 10 drums

of retort water were shipped to US Department of Energy, Laramie, WY. Process conditions were documented, process streams were sampled and subjected to chemical analysis, and material balance calculations were made. 6 refs., 12 figs., 14 tabs.

0410 Environmental Aspects

46924 (PB–89-191043/XAB) **Parachute Creek Shale Oil Program. Environmental monitoring plan, Annual report, October 1, 1987-September 30, 1988.** Unocal Corp., Parachute, CO (USA). Energy Mining Div. 31 Mar 1989. 60p. (REPT–89-1A). Available from NTIS, PC A04/MF A01.

See also PB–89-147292.

The Energy Security Act of 1980 established a program to provide financial assistance to private industry in the construction and operation of commercial-scale synthetic-fuels plants. The Parachute Creek Shale Oil Program is one of four projects awarded financial assistance. The support agreement included development of an Environmental Monitoring Plan incorporating existing compliance monitoring and supplemental monitoring on water, air, solid waste, worker health and safety, and socio-economic impacts during the period 1986-1993. Phase I of the project is to produce 10,000 barrels per day of syncrude from oil shale, using the Unishale 'B' process. The compliance monitoring data and implementation of supplemental sampling for source monitoring and industrial hygiene monitoring are described.

05 NUCLEAR FUELS

0501 Reserves, Exploration, and Mining

Refer also to citation(s) 46984

46925 (DOE/EIA–0478(88)) **Uranium industry annual, 1988.** USDOE Energy Information Administration, Washington, DC (USA). Office of Coal, Nuclear, Electric and Alternate Fuels. 31 Aug 1989. 121p. Sponsored by U.S. DOE Management & Administration. Order Number DE89017709/JAW. Available from NTIS, PC A06/MF A01 - GPO; OSTI; INIS; GPO Dep.

This report presents data on US uranium raw materials and marketing activities of the domestic uranium industry. It contains aggregated data reported by US companies on the "Uranium Industry Annual Survey" (1988), Form EIA-858, and historical data from prior data collections and other pertinent sources. The report was prepared by the Energy Information Administration (EIA), the independent agency for data collection and analysis with the US Department of Energy.

46926 (INIS-mf–11534) **Jabiluka gold-uranium project.** Pancontinental Mining Ltd., Sydney (Australia). 1988. 6p. Order Number DE90601286/JAW. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS.

The Jabiluka gold-uranium deposit, 230km east of Darwin in the Alligator Rivers Region of the Northern Territory, was discovered by Pancontinental Mining Limited in 1971. Jabiluka, with reserves in excess of 200,000 tonnes of contained U_3O_8 in two deposits 500 metres apart, is the world's largest high grade uranium deposit and also contains nearly 12 tonnes of gold. It is proposed that only the larger deposit, Jabiluka II will be mined - by underground extraction methods, and that 275,000 tonnes of ore per year will be mined and processed to produce 1,500 tonnes of U_3O_8 and up to 30,000 oz of gold. The revenue from the uranium sales is estimated to be of the order of A$100 million per year at A$30/lb. By the end of 1982 all necessary mining and environmental approvals had been obtained and significant marketing progress made. With the Australian Labor Party winning Commonwealth Government in the 1983 election, Pancontinental's permission to seek sales contracts was withdrawn and development of the Jabiluka deposit ceased. Jabiluka remains undeveloped - awaiting a change in Australian Government policy on uranium. figs., maps.

0505 Uranium Enrichment

46927 (ENEA-RT-COMB–87-15) **REIMIEP 1987: an interlaboratory U-235 enrichment determination by gamma measurement on solid UF6 sample.** Aparo, M.; Cresti, P. ENEA, Rome (Italy). Mar 1988. V Order Number DE88755371/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

Gamma spectrometry techniques, based on the measurement of U^{235} (186 KeV), are now currently used for the determination of uranium enrichment in different nuclear fuel cycle materials, namely: metallic uranium, uranium dioxide pellets, and liquid or solid uranium hexafluoride. This paper describes the use of such a technique and the results obtained in determining the U^{235} /U atomic isotopic abbundance in a certified uranium hexafluoride solid sample. The measurements have been carried out in the framework of the partecipation to the "Uranium Hexafluoride Interlaboratory Measurement Evaluation Programme" organized by CBNM/Geel with the support of the ESARDA (European Safeguards Research and Development Association).

46928 (LA–11646-MS) **Mathematical determination of α and β for the rotating-slit enrichment monitor.** Stirpe, D.; Hafer, J.F. Los Alamos National Lab., NM (USA). Oct 1989. 19p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE90000004/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

To measure the ^{235}U enrichment of UF_6 gas in header pipes of enrichment facilities using the enrichment monitor, it is necessary to determine the geometrical factors, α and β. We report on a method of calculating the values of these factors through numerical integration of Lambert's Law. The header pipe diameter, the dimensions of the collimating slit, the diameter of the gamma-ray detector, and the distance of this detector from the axis of the header pipe determine the geometrical configuration of the problem. The limits of integration are obtained by the condition that the radiating volume of UF_6 gas, dV, must be able to "see" the element of detector area, dA, through the collimating slit. Expressions for these limits are derived by using three-dimensional analytical geometry. Additional limits on dV are given by the pipe diameter, and additional limits on dA are given by the slit width or the detector diameter. Effects of attenuation of the gamma-ray signal through the pipe wall are also calculated. The distance of the gamma-ray signal through the pipe wall depends on the positions of dV and dA; this distance can also be obtained by using three-dimensional analytical geometry. Values for α and β are given for the three pipe diameters, 4, 7, and 10 cm, for a slit length of 7.3 cm, and for the slit widths, 1, 2, 3, 4, and 5 cm. 3 refs., 11 figs., 4 tabs.

0507 Fuels Production and Properties

Refer also to citation(s) 47097, 47109, 47120

46929 (DOE/RL–89-21) **Application for approval for construction of the Fueled Clad Fabrication System, the Radioisotope Power Systems Facility, and the Fuel Assembly Area.** USDOE Richland Operations Office, WA (USA). Aug 1989. 42p. Sponsored by U.S. DOE Nuclear Energy. Order Number DE89017226/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The following "Application for Approval of Construction" is being submitted by the US Department of Energy-Richland Operations Office, pursuant to 40 CFR 61.07, for three new sources of airborne radionuclide emissions at the Hanford Site in Washington State. The three new sources, the Fueled Clad Fabrication System (FCFS), the Radioisotope Power Systems Facility (RPSF), and the Fuel Assembly Area (FAA), will be located in one facility, the Fuels and Materials Examination Facility (FMEF) of the 400 Area. The FMEF was originally designed to provide for post-irradiation examination and fabrication of breeder reactor fuels. These FMEF missions were canceled before the introduction of any fuel materials or any irradiated material. The current plans are to use the facility to fabricate power supplies to be used in space applications and to produce Fast Flux Test Facility (FFTF) fuel and target assemblies. The FCFS and the RPSF will produce materials and assemblies for application

in space. The FAA project will produce FFTF fuel and target assemblies. The FCFS and the RPSF will share the same building and stack and, in certain cases, the same floor space. Given this relationship, these systems will be dealt with separately to the extent possible. The FAA is a comparatively independent operation though it will share the FMEF complex. 2 refs., 16 figs., 12 tabs.

46930 (LA–11586-MS) **High-temperature materials compatibility testing of refractory crucible materials: TaC, Y_2O_3, Y_2O_3-coated MgO, and BN.** Axler, K.M.; Foltyn, E.M. Los Alamos National Lab., NM (USA). Sep 1989. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE89017746/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Selected refractory materials were examined for potential application in the pyrochemical processing of PuO_2. Presently, MgO crucibles are used for containment. Experiments were performed on carburized Ta, Y_2O_3, Y_2O_3-coated MgO, and BN so that their viability as containment materials could be determined. Additionally, we performed materials compatibility testing on a carburized Ta cell to evaluate its potential application in salt regeneration. In this process, multiple direct oxide reduction is made possible by the in situ regeneration of $CaO{\cdot}CaCl_2$ by reaction with Cl_2 at elevated temperatures. 8 refs., 2 figs.

0508 Spent Fuels Reprocessing

Refer also to citation(s) 46930, 47481, 47548, 47959

46931 (JAERI-M–89-014) **Development of the computer code TRANS-ACE for analysing radioactive materials transport in reprocessing plants under accidental conditions.** Nishio, Gunji; Abe, Hitoshi; Naito, Yoshitaka. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1989. 180p. (In Japanese). Order Number DE90701623/JAW. Available from NTIS (US Sales Only), PC A09/MF A01.

The computer code TRANS-ACE has been developed for safety evaluation of cell-ventilation system of reprocessing plants under postulated fire or explosion accident conditions, by adding the functions to the one dimensional compressible heat flow analysis code EVENT developed by Los Alamos National Laboratory of USA for calculating the transport of aerosol or radioactive material, heat flow dynamics and source terms under the condition of explosion. This code can not only calculate pressure, temperature but also material transport and finally the quantity of released radioactive materials passed through the High Efficiency Air Filter (HEPA filter). This document is detailed an explanation on the code as well as user's manual. (author).

46932 (JAERI-M–89-032) **Safety demonstration test on solvent fire in fuel reprocessing plant.** Nishio, Gunji; Hashimoto, Kazuichiro. Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1989. 137p. (In Japanese). Order Number DE90701679/JAW. Available from NTIS (US Sales Only), PC A07/MF A01.

This report summarizes a fundamental of results obtained in the Reprocessing Plant Safety Demonstration Test Program which was performed under the contract between the Science and Technology Agency of Japan and the Japan Atomic Energy Research Institute. In this test program, a solvent fire was hypothesized, and such data were obtained as fire behavior, smoke behavior and integrity of exhaust filters in the ventilation system. Through the test results, it was confirmed that under the fire condition in hypothetical accident, the integrity of the cell and the cell ventilation system were maintained, and the safety function of the exhaust filters was maintained against the smoke loading. Analytical results by EVENT code agreed well with the present test data on the thermofluid flow in a cell ventilation system. (author).

46933 (PNL–6969) **The compatibility of various polymeric liner and pipe materials with simulated double-shell slurry feed at 90°C: Hanford Grout Technology Program.** Farnsworth, R.K.; Hymas, C.R. Pacific Northwest Lab., Richland, WA (USA). Aug 1989. 162p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. Order Number DE89016552/JAW. Available from NTIS, PC A08/MF A01; OSTI; INIS; GPO Dep.

The purpose of this study was to evaluate the compatibility of various polymeric liner and pipe materials with a low-level radioactive waste slurry called double-shell slurry feed (DSSF). The evaluation was necessary as part of the permitting process authorized by the Resource Conservation and Recovery Act (RCRA), PL-94-580. Materials that were examined included five flexible membrane liners (Hytrel® polyester, polyurethane, 8130 XR5®, polypropylene, and high-density polyethylene) and high-density polyethylene (HDPE) pipe. The liner and pipe samples were immersed for 120 days in the synthetic DSSE at 90°C, the maximum expected temperature in the waste disposal scenario. Physical properties of the liner and pipe samples were measured before immersion and every 30 days after immersion, in accordance with EPA Method 9090. In addition, some of the materials were exposed to four different radiation doses after 30 days of immersion. Physical properties of these materials were measured immediately after exposure and after an additional 90 days of immersion to determine each material's response to radiation, and whether radiation exposure affected the chemical compatibility of the material. 20 refs., 41 figs., 13 tabs.

0509 Transport and Storage

Refer also to citation(s) 47009, 47779

46934 (CONF-881054–Vol.3, pp. 945-950) **Ontario Hydro training program for shipping radioactive materials.** Hudson, J. (Ontario Hydro, Toronto (Canada)); Watson, C.T. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 3.* Order Number DE89014702/JAW. Available from NTIS, PC A14/MF A01.

The Radioactive Waste Management Section, RMEP, of Ontario Hydro holds the lead responsibility for ensuring that all operational aspects of any Federal or Provincial legislation dealing with transportation are properly implemented. The authors provide personnel in the field with relevant information so that all applicable changes are incorporated into radioactive material transportation procedures throughout Ontario Hydro. A specific effort to implement a training/compliance program was started shortly before the Transportation of Dangerous Goods regulations were implemented in July 1985. Part IX of these regulations require training of all personnel involved in the transport of dangerous goods to the extent of their involvement. The authors were faced with three major challenges, the MATERIAL and AUDIENCE and the URGENCY. Considering these challenges there was a need for MAJOR INITIAL EFFORT, LONG TERM UPKEEP and FEEDBACK ON EFFECTIVENESS.

0520 Waste Management

Refer also to citation(s) 46984, 46988, 46989, 47000, 47001, 47002, 47003, 47004, 47987, 48027

46935 (CONF-881054–Vol.3, pp. 747-761) **French low-level waste characterization and certification.** Hutchison, C.A. (NUMATEC, Inc., Washington, DC (USA)); Hoxie, C.L.; Van Hoesen, S.D.; Kennerly, J.M. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 3.* Order Number DE89014702/JAW. Available from NTIS, PC A14/MF A01.

The low-level waste characterization and certification program utilized in France will be described. The French program is comprised of several important components, including: application of acceptance criteria; development of a Process Book which describes the waste generating process, characterizes the waste, and describes any stabilization or other processes applied to the waste; and conduct of a quality assurance program to ensure that wastes continue to meet the acceptance criteria. The results of a test program in which the French characterization and certification process was applied to several DOE facility low-level waste streams will be presented.

46936 (CONF-881054--Vol.3, pp. 763-774) **Evaluation of commercially available radionuclide assay equipment suitable for solid LLW characterization/certification.** Allen, D.F. (Lee Wan and Associates, Inc., Oak Ridge, TN (USA)); Goldsmith, W.A.; Van Hoesen, S.D. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 3.* Order Number DE89014702/JAW. Available from NTIS, PC A14/MF A01.

An evaluation of commercially available radionuclide assay equipment was performed to determine what equipment may be used for characterizing and certifying (through remeasurement) solid low-level radioactive waste (LLW) generated and/or disposed of on the Oak Ridge Reservation (ORR). Most emphasis was placed on nondestructive remeasurement of packaged wastes and on wastes that are difficult to characterize due to their form. The application of these measurements was then discussed for six specific LLW streams. Some readily available equipment for this measurement is available but is necessarily limited to detecting those radionuclides which are gamma ray or neutron emitters. The future possibility of measuring ^{99}Tc through neutron activation was also examined.

46937 (CONF-881054--Vol.3, pp. 775-781) **Nondestructive assay and real-time radiography requirements for remote-handled wastes at the proposed WHPP facility.** Caldwell, J.T. (Pajarito Scientific Corp., Los Alamos, NM (USA)); Goldsmith, W.; Turner, D.W.; Schultz, F.J. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 3.* Order Number DE89014702/JAW. Available from NTIS, PC A14/MF A01.

Nondestructive assay (NDA) and real-time radiography (RTR) measurements of remote-handled transuranic (RH-TRU) waste packages are complicated by typical contact gamma ray dose rates up to 10,000 R/h. Most NDA and nondestructive examination (NDE) instrumentation used to certify contact-handled CH-TRU wastes cannot be operated in high gamma ray fluxes. Correspondingly, 420 kev x-ray sources and imaging devices used routinely on CH wastes are not suitable for RH wastes. The greater than one R/h neutron dose rates typical of some ORNL RH wastes create additional measurement problems. The constraints of fitting all NDA and RTR hardware into a limited portion of a multi-function facility present yet more design difficulties. Using the same hardware to service incoming (possibly surface contaminated) and fully processed packaged results in another complication. One attractive option meeting all basic NDA and RTR requirements is provided by a 6 MV electron linac - properly shielded, with directional collimation. The linac would be the driving source for highly penetrating RTR measurements as well as for high sensitivity NDA measurements based on a combination of the pulsed-neutron differential dieaway technique and the independent pulsed-photofission method.

46938 (CONF-881054--Vol.3, pp. 783-796) **Waste certification at the Y-12 Plant.** Bailey, J.K. (Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA)); Howard, S.C.; Jones, L.S. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 3.* Order Number DE89014702/JAW. Available from NTIS, PC A14/MF A01.

The ability to certify wastes at the Oak Ridge Y-12 Plant for the purposes of storage or disposal is being enhanced to comply with evolving regulatory requirements for existing facilities, and proposed certification strategies for future waste disposal facilities as described in the Low Level Waste Disposal Development and Demonstration Program strategy. The Y-12 program consists of four levels of characterization and certification including solids/liquids, determination, hazard verification, general characterization, and quantification of concentrations of radioisotopes. In order to enhance overall certification capabilities at the plant several improvements to the existing program are in progress or scheduled. These include the construction of a new facility with improved instrumentation for monitoring radioisotope concentrations in bulk (dumpster) quantities, as well as improvements to an existing facility to lower its detection limit for depleted uranium contamination. Also included is the acquisition of waste curie monitors using passive plastic scintillation detectors to monitor small waste containers, and a nuclear material monitor which utilizes thermal-neutron and fast-neutron interrogation to determine radioisotope content.

46939 (CONF-881054--Vol.3, pp. 797-805) **Mixed waste characterization and certification at the Nevada Test Site.** Kawamura, T.A. (Reynolds Electrical and Engineering Co., Inc., Las Vegas, NV (USA)); Dodge, R.L.; Fitzsimmons, P.K. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 3.* Order Number DE89014702/JAW. Available from NTIS, PC A14/MF A01.

The Radioactive Waste Management Project (RWMP) at the Nevada Test Site (NTS) was recently granted interim status by the state of Nevada to receive mixed waste (MW). The RCRA Part B permit application has been revised and submitted to the state. Preliminary indications are that the permit will be granted. In conjunction with revision of the Part B Permit application, pertinent DOE guidelines governing waste acceptance criteria (WAC) and waste characterization were also revised. The guidelines balance the need for full characterization of hazardous constituents with as low as reasonably achievable (ALARA) precepts. Because it is not always feasible to obtain a full chemical analysis without undue or unnecessary radiological exposure of personnel, process knowledge is considered an acceptable method of waste characterization. A balance of administrative controls and verification procedures, as well as careful documentation and high standards of quality assurance, are essential to the characterization and certification program developed for the NTS.

46940 (CONF-881054--Vol.3, pp. 861-876) **Summary of findings on evaluation of aqueous degreasers versus chlorinated solvents at the Paducah Gaseous Diffusion Plant.** Gunn, D. (Martin Marietta Energy Systems, Inc., Paducah, KY (USA)). Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 3.* Order Number DE89014702/JAW. Available from NTIS, PC A14/MF A01.

Spent trichloroethylene (TCE), 1,1,1-trichloroethane (TC-ane), and sludge are generated mainly as a result of vapor degreasing operations at the Paducah Gaseous Diffusion Plant (PGDP). Additionally, small quantities of spent chlorinated solvents are generated as a result of small parts cleanup. These wastes are listed hazardous wastes under Resource Conservation and Recovery Act (RCRA) regulations (40 CFR 261) and account for greater than 50% of the hazardous waste generated at PGDP. Additionally, some of the solvents become contaminated with uranium which classifies them as mixed waste for which no disposal method is currently available. TCE and TC-ane are both associated with potential health hazards and are subject to a number of environmental regulations. Due to health and environmental concerns and the desire to minimize mixed and hazardous waste generation, a study was initiated to identify nonchlorinated, less toxic degreasers, perform laboratory testing of the most promising alternatives, and initiate field testing to determine if alternate degreasers present operational problems. The degreaser that cleaned and protected metal surfaces best was an all-purpose, water-based, hard surface cleaner consisting of biodegradable synthetic detergents, inorganic builders, and a glycol ether solvent. Additionally, this product was free-rinsing and did not leave any contaminants that would react with commonly used process gases. This product is recommended as a replacement for chlorinated solvents for many degreasing operations at PGDP.

46941 (CONF-881054--Vol.3, pp. 903-914) **Remedial technology screening method.** Young, J.D. (CER Corp., Oak Ridge, TN (USA)); Watkins, D.R. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 3.* Order Number DE89014702/JAW. Available from NTIS, PC A14/MF A01.

Determination of the most effective remediation technologies to apply to hazardous waste sites requires analysis of complex sets of

data and evaluation of trade-offs based on limited resources. Currently, remedial technologies are in various stages of active development, and as a result, performance and implementation requirements are evolving continually. In many cases, no single technology represents a clearly superior option either technically or economically based on site characteristics and regulations that dictate remediation requirements. This paper presents a comprehensive method to rapidly screen and evaluate remedial alternatives. The purpose of the screening process is to perform the first cut at selecting the most feasible technology (or group of technologies) for remediation of specific hazardous waste sites. The method is a systematic guide expressed in matrix form to indicate the technology or technologies that will do the best job at specific sites within institutional constraints and limits of available resources. Technologies for cleaning up contaminated soils and migrating contaminant plumes in groundwater will be considered with emphasis on technical effectiveness, implementability, and costs.

46942 (CONF-881054–Vol.3, pp. 951-965) **Environmental sampling technician training program.** Moreland, W.M. (Oak Ridge National Lab., TN (USA)). Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 3.* Order Number DE89014702/JAW. Available from NTIS, PC A14/MF A01.

The Oak Ridge National Laboratory (ORNL) is currently involved in extensive environmental monitoring activities to characterize various active/inactive waste sites that exist at the facility. There are also considerable reporting requirements that ORNL must meet on a continuing basis in order to remain in compliance with existing permit requirements under the Resource Conservation and Recovery Act (RCRA), the Clean Air Act (CAA), and the Clean Water Act (CWA). Much of the environmental monitoring data that is used to characterize waste sites or is required in reports is obtained by environmental sampling technicians who must take samples at various locations throughout ORNL as well as other DOE installations. Because of the quality control and assurance measures included under NQA-1, ORNL has developed an Environmental Sampling Technician Training program. This presentation will describe how the Environmental Sampling Technician Training Program was developed and review the specific materials used in conducting the training.

46943 (CONF-881054–Vol.4, pp. 1191-1202) **Development of a low-level radioactive waste disposal facility to serve the Central Interstate Compact.** Bradbury, P. (Bechtel National, Inc., Oak Ridge, TN (USA)); Paton, R.F. Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

The development of the low-level radioactive waste disposal facility for the Central Interstate Low-Level Radioactive Waste Compact Commission represents an excellent example of full and meaningful public participation in a sensitive technological area. From the outset, a high degree of public participation has been actively sought, and received, at every major decision stage. The balancing of this participative approach with the needs to maintain technological acceptability, comply with Federal and State regulations, and proceed in accordance with the Federally mandated milestones represents an experience from which many lessons of value can be learned.

46944 (CONF-881054–Vol.4, pp. 1203-1214) **Design features of earth mounded concrete bunkers for LLRW (low-level radioactive waste) disposal.** Tsang, I. (Ebasco Services Inc., New York, NY (USA)); Liu, P.; Eng, R.; Case, J. Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

Ebasco Services Incorporated contracted with the Department of Energy to perform a study of the Earth Mounded Concrete Bunker (EMCB) concept for a low-level radioactive waste facility. The objective of the EMCB study is to provide a technical safety analysis of an EMCB disposal facility. The facility is designed to provide reasonable assurance that the NRC performance objectives in 10 CFR 61 Subpart C can be met. The facility design, cost, and disposal concept is discussed along with general description of the site.

46945 (CONF-881054–Vol.4, pp. 1215-1226) **Design, construction, and operations experience with the SWSA 6 (Solid Waste Storage Area 6) tumulus disposal demonstration.** Van Hoesen, S.D. (Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA)); Van Cleve, J.E.; Wylie, A.N.; Williams, L.C.; Bolinsky, J. Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

Efforts are underway at the Department of Energy facilities in Oak Ridge to improve the performance of radioactive waste disposal facilities. An engineered disposal concept demonstration involving placement of concrete encased waste on a monitored concrete pad with an earthen cover is being conducted. The design, construction, and operations experience with this project, the SWSA 6 Tumulus Disposal Demonstration, is described.

46946 (CONF-881054–Vol.4, pp. 1227-1238) **Engineered surface barriers for waste disposal sites: lysimeter facility design and construction.** Phillips, S.J. (Westinghouse Hanford Co., Richland, WA (USA)); Ruben, M.S.; Kirkham, R.R. Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

A facility to evaluate performance of engineered surface carriers for confinement of buried wastes has been designed, constructed, and operations initiated. The Field Lysimeter Test Facility is located at the US Department of Energy's Hanford Site in Richland, Washington. The facility consists of 18 one-dimensional drainage and weighing lysimeters used to evaluate 7 replicated barrier treatments. Distinct layers of natural earth materials were used to construct layered soil and rock barriers in each lysimeter. These barrier designs are capable in principal of significantly reducing or precluding infiltration of meteoric water through barriers into underlying contaminated zones. This paper summarizes salient facility design and construction features used in testing of the Hanford Site's engineered surface barriers.

46947 (CONF-881054–Vol.4, pp. 1239-1248) **Design of a disposal cell for uranium mill tailings at Collin's Ranch, Oregon: A case study in informal dynamic optimization.** Beyeler, W. (Jacobs Engineering Group, Inc., Albuquerque, NM (USA)); Dupuy, J. Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

The disposal of uranium mill tailings at the DOE's UMTRAP Collins Ranch site near Lakeview, Oregon provides an informative case study in the practical ramifications of groundwater protection standards. This paper discusses the hydrologic setting, the anticipated impacts of the initial cell design, and the legislative framework in which the design was prepared. Recently mandated compliance with the proposed EPA groundwater standards presented an interesting technical challenge, as much of the construction, based on the original design, had been completed by the time these criteria were imposed. The design modification options, constrained by existing work at the site, are discussed, along with the methodology used to identify a workable design enhancement.

46948 (CONF-881054–Vol.4, pp. 1249-1259) **Eenie, meenie, minie, moe, where do Monument Valley tailings go?.** Dery, V.A. (Jacobs Engineering Group, Inc., Albuquerque, NM (USA)); Agogino, K.L.; Mann, D.E. Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

This paper described the decision making process used to select a site for the disposal and stabilization of the uranium mill tailings at the Monument Valley site. During the three years following the

spring of 1985, the Department of Energy's Uranium Mill Tailings Remedial Action Project Office went through several site selection processes for the disposal of tailings at the inactive uranium mill site on the Navajo Indian Reservation in Monument Valley, Arizona. The last site selection process was initiated as a direct consequence of the proposed groundwater protection standards (40 CFR 192) published by the US Environmental Protection Agency (EPA) during the fall of 1987. Before the proposed standards were issued, work on the conceptual design (disposal option) for remedial action was near completion. Assessment of the proposed EPA standards revealed that the current design was not in compliance with the regulations. Work on the Environmental Assessment and the Remedial Action Plan stopped. A paper study of alternate disposal sites was initiated at the beginning of 1988, in addition to exploring ways (via new technologies) to use existing and previously rejected disposal options. New criteria for evaluation of all viable options were established in light of the new standards. Probable costs were developed for those options that had significant environmental risks associated with them so they could be compared with those options of little or no associated risk. As a direct result of this decision making process, an option that was previously rejected because of the high cost, but that had relatively little associated risk, was selected as the recommended option.

46949 (CONF-881054–Vol.4, pp. 1261-1271) **Drumlins - Potential low-level radioactive waste sites.** Maxwell, H.W. Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

A drumlin is a subglacially produced low, streamlined elongate oval hill, mound or ridge with its long axis parallel to the direction of ice flow. It may be composed entirely of till, particularly basal till, or it may have a bedrock core and a relatively thin till outer layer. Most drumlins are less than a half mile long, 400 to 600 feet wide at their base and less than 100 feet high. There are some that are more than a mile long, 1500 to 2000 feet wide and more than 200 feet high. A drumlin has many characteristics which are advantageous to the siting of a low-level radioactive disposal facility. Most drumlins in New York State are composed of basal till which, because of its mode of deposition, may be as dense and impervious as concrete. This composition makes several disposal concepts feasible. Preliminary data and conceptualization indicates a subsurface mined repository paralleling the long axis of a drumlin would meet physical, environmental and long range public safety requirements. A drumlin site could answer many intervenor concerns such as longevity, esthetics, monitoring ability, and inadvertent entry. This paper will describe the structure, composition and engineering significant of the components of a drumlin and will present some alternative concepts for LLRW disposal using a drumlin as a host.

46950 (CONF-881054–Vol.4, pp. 1367-1378) **Assessment of potential worker exposure during the operational phase of the Tumulus disposal demonstration project.** Styers, D.R. (Automated Sciences Group, Inc., Oak Ridge, TN (USA)). Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

The Oak Ridge National Laboratory has a continuing commitment to improve waste management and storage practices for solid low level radioactive wastes (LLW). The Tumulus Disposal Demonstration Project was chosen by the Low Level Waste Disposal Development and Demonstration (LLWDDD) program as one of the disposal technologies that is being evaluated to dispose of this waste in an environmentally acceptable manner. For this project, primary waste packages containing dry, solid LLW with contact dose equivalent rates less than 200 millirem per hour were placed into secondary concrete disposal vaults and the void spaces filled with a concrete grout mix. The completed units were then placed on the Tumulus pad. To assess potential worker exposure for this disposal technology, the radiation field at the site was surveyed. Measurements of worker exposures during the loading operations necessary to prepare and to emplace the LLW were conducted. The goal is to develop a database sufficient to compare worker exposures for disposal facilities of different designs.

46951 (CONF-881054–Vol.4, pp. 1393-1402) **Hydrologic evaluation of seven proposed cap designs.** Yager, R.E. (Environmental Consulting Engineers, Inc., Knoxville, TN (USA)); Manrod, W.E. III; Craig, P.M. Analysas Corp., Oak Ridge, TN (USA) 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

Closure of landfills, surface impoundments, trenches and other waste disposal areas involves an engineered cover to promote surface runoff and evapotranspiration and minimize erosion and infiltration. The purpose is to minimize the contact of precipitation with the waste and, therefore, minimize the production of leachate. The relative hydrologic performances of several cap designs were compared with the computer model Hydrologic Evaluation of Landfill Performance (HELP). Results available from the model include runoff, evapotranspiration, lateral drainage within the cover and percolation of water through the cap. The relative magnitude of the results were used as a basis to determine cap effectiveness. All designs used compacted clay as the bottom barrier layer and vegetated topsoil at the surface. One design was identical to the expected RCRA guidance cap and the performances of other cap designs were compared with that design. Both sand and geonets were used for lateral drainage layers and the hydrologic performance of geosynthetics has been evaluated. Estimates of the covers cost have been made and the economic benefits of various innovative designs are presented.

46952 (CONF-881054–Vol.4, pp. 1403-1413) **Field demonstration of in situ vitrification for application to ORNL liquid waste disposal trenches.** Spalding, B.P. (Oak Ridge National Lab., TN (USA)); Jacobs, G.K. Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

A field-scale vitrification of a cold (nonradioactive) model of an old seepage trench was completed on July 20, 1987, by personnel of Battelle Pacific Northwest Laboratories in cooperation with ORNL. An estimated 20 tons of soil and crushed limestone backfill were melted. The desired melting depth of 2 m was achieved. The molten mass tended to grow parallel to the long axis of the trench rather than symmetrically around the square array of electrodes. All melt geometry, safety, and process performance objectives were achieved satisfactorily. A 2-month cooling period was required before core sampling of the vitrified product was initiated. Samples of the off-gas scrub solutions have indicated that 99.88% and > 99.99% of the cesium and strontium tracers, respectively, were retained in the trench. Samples of the field-produced material were found to be as good or better than two standard high-level nuclear vitreous waste forms using standard leach tests. Approximately half of the block devitrified or crystallized to pseudowollastonite and anorthite mineral phases during cooling. However, devitrification produced no significant change in the leach properties of the material.

46953 (CONF-881054–Vol.5, pp. 1439-1447) **Impacts from the implementation of a prioritization system for funding inactive waste site remediation activities at the Savannah River Plant.** St. Clair, G.T. (NUS Corp., Aiken. SC (USA)); Browning, D.S.; Whitaker, W.C. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 5.* Order Number DE89014704/JAW. Available from NTIS, PC A13/MF A01.

The US Department of Energy (DOE) has established an Environmental Restoration (ER) Program budget category to fund investigation and remedial activities at DOE Defense Programs (DOE-DP) inactive waste sites. The ER activities are required by Section 3004(u) of the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA). Funds to be

appropriated by Congress for this effort through 1993 are expected to exceed one-half billion dollars. Due to overlapping regulatory requirements and the number of inactive waste sites at DOE-DP installations, a system has been established to determine how the funding should be allocated. DOE is developing a prioritization system that will rank environmental investigation and remediation programs. This paper examines impacts that the prioritization system may have on the Savannah River Plant, including remedial action schedules previously negotiated with Federal and state regulatory agencies.

46954 (CONF-881054–Vol.5, pp. 1487-1497) **Correlation between radwaste processing and hazardous waste treatment processes.** Block, O.U.J. (Ebasco Services Inc., South Plainfield, NJ (USA)); Tulipano, F.J. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 5.* Order Number DE89014704/JAW. Available from NTIS, PC A13/MF A01.

The basic framework under SARA has established that preferred remedies are those which permanently and significantly reduce toxicity, mobility or volume of wastes. In the 1970's radwaste process designs at power plants received pressure to satisfy essentially the same criteria when increased emphasis was placed on limited disposal sites which resulted in rapidly escalating disposal costs. This paper provides a historical perspective of radwaste experience and discusses valuable insight to hazardous waste treatment technologies. The radwaste system experience is discussed in terms of providing a source of proven and reliable technologies. Discussion is presented on specific radwaste processes which are applicable technologies for hazardous waste treatment. The technologies presented include (a) Solidification, (b) Evaporation, and (c) Incineration. Experience is presented which establishes assurance that the treatment technologies will provide a permanent remedy to hazardous waste treatment. This paper describes typical radwaste solidification, evaporation and incineration processes at power plants. The design requirements and implementation of radwaste equipment is correlated to design requirement of hazardous waste equipment. Specific discussion is provided on how the available process equipment can reduce toxicity, mobility, and volume of waste. Discussion is presented on how the standard off the shelf processing equipment needs to be modified for radwaste and hazardous waste applications.

46955 (CONF-881054–Vol.5, pp. 1529-1540) **Decontamination and coating of lead.** Rankin, W.N. (E. I. du Pont de Nemours and Co., Aiken, SC (USA)); Bush, S.P.; Lyon, C.E.; Walker, V. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. DOE Contract AC09-76SR00001. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 5.* Order Number DE89014704/JAW. Available from NTIS, PC A13/MF A01.

Technology is being developed to decontaminate lead used in shielding applications in contaminated environments for recycle as shielding. Technology is also being developed to coat either decontaminated lead or new lead before it is used in contaminated environments. The surface of the coating is expected to be much easier to decontaminate than the original lead surface. If contamination becomes severely embedded in the coating and cannot be removed, it can be easily cut with a knife and removed from the lead. The used coating can be disposed of as radioactive (hot hazardous) waste. The lead can then be recoated for further use as a shielding material.

46956 (CONF-881054–Vol.5, pp. 1621-1633) **Internal monitoring system for radioactive waste disposal - 1988 conclusions.** Blanke, J.A. (Bechtel National, Inc., Oak Ridge, TN (USA)); McConnel, B.C. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 5.* Order Number DE89014704/JAW. Available from NTIS, PC A13/MF A01.

The data collected to date supports the conclusion that the use of internal monitoring devices to detect the water behavior within a waste storage cell provides an opportunity to respond to indications of cell structural distress before the cell has begun to discharge water contaminated by the wastes. A delay after containment structure failure always occurs before discharged water is identified by the environmental monitoring program. The internal monitoring system provides continuous data about local and general internal conditions. The instrumentation can identify local elements of the containment that need more intensive inspection. The instrumentation offers the ability to identify areas within the containment where liquid extraction or cap repair may be desirable. The internal monitoring system can be replaced at the end of its design life, which provides the flexibility to indefinitely extend the intensive monitoring period of a facility. Since the need to extend the monitoring depends on the individual facility's behavior, the flexibility to extend the system life is an important capability. Therefore, the internal monitoring system provides timely, accurate, and reliable information for planning and evaluating the behavior of the containment structure.

46957 (CONF-881054–Vol.5, pp. 1635-1647) **Demonstration of new handling equipment configurations for the overpacking of thorium materials.** Mihalovich, G.S. (Westinghouse Materials Co. of Ohio, Cincinnati (USA)); Heisler, S.W. Jr. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 5.* Order Number DE89014704/JAW. Available from NTIS, PC A13/MF A01.

A remote handling system has been designed for the removal and overpacking of thorium materials currently stored at the Feed Materials Production Center (FMPC). The FMPC is the Department of Energy (DOE) designated interim storage location for thorium materials. The nature of thorium materials indicated that a system to reduce exposure, assure environmental protection, and provide positive identification of the materials be devised. The result of this was the development and implementation of a remote handling system utilizing existing technologies but integrating them into a system that had previously not been used. The equipment used involves: remote controlled cranes, conveyers, sensing equipment and overpacks; a computer based central control and processing system that also provides cross data correlation; a shielded handling unit with multiple articulation capability and an environmentally isolated work area; and significant shielding at the operators station while the operator works in an enclosed, but mobile environment. These measures were prompted by both As Low As Reasonably Achievable (ALARA) considerations for the employees and protection for the environment. The overpacking is required due to the environmental deterioration that is occurring to both the building and containers resulting in the need for this operation to be initiated to assure the continued safe storage of these materials.

46958 (CONF-890854–12) **Performance assessment for future low-level waste disposal facilities at ORNL.** Lee, D.W.; Kocher, D.C. Oak Ridge National Lab., TN (USA). 1989. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OR21400. From 11. annual DOE low level waste management conference; Pittsburgh, PA (USA); 22-24 Aug 1989. Order Number DE89016873/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper discusses the strategy for waste management on the Oak Ridge Reservation (ORR) and the approach to preparing future performance assessments that has evolved from previous performance assessment studies of low-level radioactive waste disposal on the ORR. The strategy for waste management is based on the concept that waste classification should be determined by performance assessment other than the sources of waste. This dose-based strategy for waste classification and management places special importance on the preparation and interpretation of waste disposal performance assessments for selecting appropriate disposal technologies and developing waste acceptance criteria. Additionally, the challenges to be overcome in the preparation of performance assessments are discussed. 7 refs.

46959 (CONF-8609134–, pp. 10-19) **EQ3/6 - Status and future development.** Wolery, T.J. (Lawrence Livermore National Lab., CA (USA)). Lawrence Livermore National Lab., CA (USA). 1986. From Workshop on geochemical modeling; Fallen Leaf Lake,

CA (USA); 14-17 Sep 1986. In *Proceedings of the workshop on geochemical modeling.* Order Number DE89008807/JAW. Available from NTIS, PC A09/MF A01.

EQ3/6 is a software package for geochemical modeling of aqueous systems, focused on speciation-solubility and reaction-path modeling. It includes a large thermodynamic data base and a collection of data base handling programs. EQ3/6 is being developed primarily for applications related to the disposal of high level nuclear waste, but the software is much more widely applicable in aqueous geochemistry. Recent work has focused on growth and improvement in the data base, creation of data base management software, the introduction of precipitation growth kinetics into reaction-path modeling, an option to compute reaction paths at fixed gas fugacities, improvements in the treatment of solid solutions, and inclusion of equations to represent activity coefficients in concentrated aqueous salt solutions. In addition, the coding has changed from FORTRAN 66 to FORTRAN 77, and a set of coding standards has been developed in order to assist code portability and future development.

46960 (CONF-8609134–, pp. 86-93) **Predicted reaction paths during the hydrothermal alteration of Columbia River basalt: A sensitivity analysis of variability in the composition of the mesostasis.** Arthur, R.C. (Rockwell Hanford Operations, Richland, WA (USA)). Lawrence Livermore National Lab., CA (USA). 1986. From Workshop on geochemical modeling; Fallen Leaf Lake, CA (USA); 14-17 Sep 1986. In *Proceedings of the workshop on geochemical modeling.* Order Number DE89008807/JAW. Available from NTIS, PC A09/MF A01.

Theoretical simulations of hydrothermal reactions of Columbia River Basalts and groundwater, using EQ3/6, show significant differences in the predicted concentrations of aqueous components and in predicted alteration mineralogy depending on small compositional differences in the solid reactants used in the models. This sensitivity is not a simple function of the differences in composition of the reactants. Mass balance considerations show that the variations are due to both the differences in the reactant compositions and the similarity of the predicted amounts of the components precipitated in alteration minerals. When applied to reaction-path models, sensitivity analyses must be bounded by the uncertainties in measured parameters as well as by the uncertainties in the conceptual models of the system.

46961 (CONF-8609134–, pp. 120-129) **Modelling interaction of deep groundwaters with bentonite.** Wanner, H. (OECD Nuclear Energy Agency, Gif-sur-Yvette (France)). Lawrence Livermore National Lab., CA (USA). 1986. From Workshop on geochemical modeling; Fallen Leaf Lake, CA (USA); 14-17 Sep 1986. In *Proceedings of the workshop on geochemical modeling.* Order Number DE89008807/JAW. Available from NTIS, PC A09/MF A01.

Based on available experimental data on the interaction of sodium bentonite and groundwater, a model has been developed which represents means of extrapolation from laboratory data to the conditions in compacted bentonite. The basic reactions between sodium bentonite and groundwater are described by an ion-exchange model for sodium, potassium, magnesium and calcium. The model assumes equilibrium with calcite and quartz. All calculations are carried out for two types of granitic groundwater: the Swiss Reference Groundwater (I = 0.24 M) and the Standard Swedish Groundwater (I = 0.0044 M). It is calculated that the pore water of compacted sodium bentonite will have a pH of 9.7 and a carbonate activity of 8×10^{-4} M in the Swiss case, and pH $\approx$ 10.2 and $(CO_3^{2-}) = 8 \times 10^{-3}$ M in the Swedish case. The long-term situation, which is important for nuclear waste disposal, is modelled by the assumption that the near-field of a radioactive waste repository behaves like a mixing tank. In this way, an attempt is made to account for the continuous water exchange between the near-field and the host rock. It is calculated that sodium bentonite will be slowly converted to calcium bentonite. The time period for this transformation is estimated to be in the order of 10^6 years, depending on the groundwater flow and composition and the dimensions of the repository.

46962 (CONF-8609134–, pp. 138-145) **Thermodynamic and kinetic modeling of glass leaching in a waste package environment.** Grambow, B. (Hahn-Meitner-Institut Berlin (West Germany)). Lawrence Livermore National Lab., CA (USA). 1986. From Workshop on geochemical modeling; Fallen Leaf Lake, CA (USA); 14-17 Sep 1986. In *Proceedings of the workshop on geochemical modeling.* Order Number DE89008807/JAW. Available from NTIS, PC A09/MF A01.

Modeling of the aqueous dissolution of nuclear waste forms is a necessary step for extrapolating short term laboratory results to the long-term performance in a repository. For nuclear waste borosilicate glasses a dissolution model GLASSOL is proposed, which combines thermodynamic reaction path calculations (PHREEQE code) with kinetic constraints. The model was developed in the frame of the JSS-project (joint Japanese, Swedish, Swiss Project) to allow interpretation of leach data from a radioactive glass delivered from COGEMA (JSS-A glass). Experimental conditions include leach tests in static and flowing solutions, variations of temperature, pH and S/V (sample surface area-to-solution volume ratio) and the presence of various waste package components (i.e. bentonite or steel corrosion products). The ongoing validation of the model is performed by a description of all major experimental results and by its application to natural analogue systems. This paper gives an overview of the key ideas in the model, and, for some experimental conditions, the results of computer simulations are compared with laboratory data.

46963 (CONF-8609134–, pp. 162-166) **EQ3/6 data base - Ongoing development at Lawrence Livermore National Laboratory.** Delany, J.M. (Lawrence Livermore National Lab., CA (USA)). Lawrence Livermore National Lab., CA (USA). 1986. From Workshop on geochemical modeling; Fallen Leaf Lake, CA (USA); 14-17 Sep 1986. In *Proceedings of the workshop on geochemical modeling.* Order Number DE89008807/JAW. Available from NTIS, PC A09/MF A01.

The EQ/6 Data Base has been revised and enhanced to meet the maintenance needs of a large continuously evolving data base. Within the last year a new data-base structure has been developed to manage the manipulation, basic data entry, import/export, retrieval and display features. The data management approach includes visual simplicity, on-line documentation, information management and controls to limit user error, ensure data protection and proper documentation of thermodynamic values and their sources.

46964 (DOE-RW–87.113) **Data acquisition and monitoring of radwaste cementation plants.** Cable, A.S.; Lee, D.J.; Samways, J.; Weller, F.C.; Williams, J.R.A. Department of the Environment, London (UK). Mar 1988. 77p. (AEEW-R–2274). Order Number DE90601725/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

This paper summarises the progress made in the two years to June 1987 on the DOE funded programme for Data acquisition and monitoring of Radwaste Cementation Plants. The results of the computer based data logging and processing system fitted to an in-drum mixing station, cement powder plant and sludge handling plant are reported. (author).

46965 (EGG-M–89245) **INEL studies concerning solidification of low-level waste in cement.** Mandler, J.W. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 4p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC07-76ID01570. (CONF-8905152–2: NIST and NRC workshop on cement solidification of low level radioactive waste, Gaithersburg, MD (USA), 31 May - 12 jun 1989). Order Number DE89016213/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The Idaho National Engineering Laboratory (INEL) has performed numerous studies addressing issues concerning the solidification of low-level radioactive waste in cement. These studies have been performed for both the Nuclear Regulatory Commission (NRC) and the Department of Energy (DOE). This short presentation will only outline the major topics addressed in some of these studies, present a few conclusions, and identify some of the technical concerns we have. More details of the work and pertinent results will be given in the Working Group sessions. The topics that have been addressed at the INEL which are relevant to this Workshop include (1) solidification of ion-exchange resins and evaporator waste in cement at commercial nuclear power plants, (2) leachability and compressive strength of power plant waste solidified in cement, (3) suggested guidelines for preparation of a solid waste process control program (PCP), (4) cement solidification of EPICOR-II resin wastes, and (5) performance testing of cement-solidified EPICOR-II resin wastes.

46966 (EPRI-NP–6494) **Evaluation of burnup credit for dry storage casks.** Wakeman, B.H.; Ahmed, S.A. Electric Power Research Inst., Palo Alto, CA (USA); Virginia Electric and Power Co., Richmond, VA (USA). c Aug 1989. 87p. Sponsored by DOE/NE;EPRI. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

In 1986 Virginia Power began storing spent LWR fuel in a metal cask Independent Spent Fuel Storage Installation (ISFSI) at its Surry Power Station. The first casks used were CASTOR V/21 storage casks supplied by General Nuclear Systems, Inc., which are designed for storage of 21 spent fuel assemblies. Like other casks, their basket is designed to maintain subcriticality even when loaded with fresh fuel assemblies. This imposes a penalty on the number of assemblies that can be loaded into the cask. Taking credit for the depletion of U235 and the buildup of fissile plutonium and non-gaseous fission products in criticality analysis is referred to as "burnup credit". In this report, the use of burnup credit for criticality control in dry storage casks is examined for several fuel types and basket and cask body materials. Several casks are analyzed for criticality, structural, shielding and thermal adequacy. Operations in spent fuel fuel pools and the controls needed to ensure proper loading of storage cask are examined. The application of burnup credit to pool storage is also addressed. The regulatory requirements for storage pools and storage casks are reviewed and the economic benefits are presented. 14 refs., 25 figs., 24 tabs.

46967 (JAERI-M–89-057) **Generation of radioactive wastes and the management.** Nakamura, Haruto. Japan Atomic Energy Research Inst., Tokyo (Japan). May 1989. 22p. (In Japanese). Order Number DE90701781/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

This paper is prepared for the lecture on radioactive waste generation, their properties and waste management to students of university in educational grade. The lecture was emphasized more on the philosophical points than on technical details. The atomic energy and radioactivity were explained briefly and problems of waste management are discussed on the reduction of the burden to future generations. (author).

46968 (K/QT–230-R) **Treatment and disposal options for a heavy metals waste containing soluble Technetium-99.** Bostick, W.D.; Shoemaker, J.L.; Osborne, P.E.; Evans-Brown, B. Oak Ridge Gaseous Diffusion Plant, TN (USA). Aug 1989. 24p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OT21400. Order Number DE89016576/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Various equipment decontamination and uranium recovery operations at the Portsmouth Gaseous Diffusion Plant generate a so-called "raffinate" waste stream characterized by toxic heavy metals, high concentrations of nitric aced, and low levels of radioactive nuclides (^{235}U and ^{99}Tc). Dilution and adjustment of solution pH to a value of 8.2 to 8.5 precipitates the heavy metals that can be hydrolyzed, which are concentrated by paper filtration to yield a filter cake designed as heavy metals sludge (HMS) and HMS filtrate. The HMS fraction may be incorporated into cement-based grout containing ground blast furnace slag to dramatically reduce the mobility of its toxic and radioactive components. Sorption of soluble mercury, pertechnetate, and nitrate anions from the HMS filtrate was tested using organic resins and inorganic sorbents. Removal of Hg and ^{99}Tc by ironing filings is efficient and economical, generating a small volume of spent sorbent amenable to co-disposal with HMS in a grout waste form. When a more rapid sorption is required, poly-4-vinylpyridine resin is very effective for the removal of soluble ^{99}Tc, with little uptake of interfering anions at near-neutral influent pH values. 37 refs., 8 figs., 6 tabs.

46969 (LA-UR–89-2630) **Geologic containment of radioactive waste.** Barr, D.W. Los Alamos National Lab., NM (USA). 1989. 15p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-36. (CONF-8907103–4: Technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). Order Number DE89016993/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In this paper we present results of our work and outline our thoughts on resolving the uncertainties associated with the nature of the solubilities and speciation of actinides, the formation of radiocolloids, the sorption behavior of fission products and actinides and the transport mechanisms of advection, diffusion, and dispersion for radionuclides under environmental conditions though to exist at Yucca Mountain, Nevada. 27 refs.

46970 (LA-UR–89-2952) **Mineralogy-petrology studies and natural barriers at Yucca Mountain, Nevada.** Bolivar, S.L.; Broxton, D.E.; Bish, D.L.; Byers, F.M.; Carlos, B.H.; Levy, S.S.; Vaniman, D.T.; Chipera, S.J. Los Alamos National Lab., NM (USA). [1989]. 10p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract W-7405-ENG-36. (CONF-890928–3: Nuclear waste isolation in the unsaturated zone: FOCUS '89, Las Vegas, NV (USA), 18-21 Sep 1989). Order Number DE89016778/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Yucca Mountain is being studied as a potential site for an underground, high-level nuclear waste repository. The site is underlain by a thick sequence of lithologically variable pyroclastic rocks. The candidate host rock is a densely welded devitrified tuff, the Topopah Spring Member of the Paintbrush Tuff. The water table is about 200–400 m below the potential repository. The types, distributions, and abundances of both rock-matrix and fracture-lining minerals along potential transport pathways between the proposed repository and accessible environment are described. Our work emphasizes the distribution of secondary minerals such as zeolites, clays, and Fe and Mn oxides because of their ability to selectivity sorb or retard certain radionuclides. We are also examining both the conditions under which mineral assemblages form and their thermal stabilities. Mineralogic and petrologic studies of the candidate host rock and the underlying units will help establish whether these rock units will act as effective, long-term natural barriers to radionuclide transport. 28 refs., 4 figs., 1 tab.

46971 (ORNL/FTR–3177) **[Review three interim reports on numerical modeling, tracer study, and monitoring design]: Foreign trip report, January 18–27, 1989.** Yeh, G.T.; Turner, R.R. Oak Ridge National Lab., TN (USA). 22 Feb 1989. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017370/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The travelers attended the meeting held at Taiwan Power Company (TPC) Headquarters in Taipei on January 18 and 19, 1989. From January 23 to January 27, 1989, G.T. Yeh conducted a workshop on fracture flow and contaminant transport at TPC Headquarters. On the first day of the technical meeting, the interim reports on groundwater movement model and tracer test at a nuclear power plant site were the subject of extensive discussion. Conclusions and recommendations were formulated and agreed upon by TPC/National Taiwan University (NTU) investigators and ORNL staff. On the second meeting, an interim report on the monitoring system was presented by NTU and comments and specific recommendations were made by ORNL. Materials covered in the workshop included five different approaches to model flow and contaminant transport in fractured media. These five approaches are (1) infinitely heterogeneous and anisotropic media, (2) equivalent porous media, (3) discrete fracture media, (4) double continuum media, and (5) discrete fracture network.

46972 (ORNL/FTR–3230) **[Preparation of a document on the subsurface disposal of liquid hazardous waste]: Foreign trip report, April 22–29, 1989.** Stow, S.H. Oak Ridge National Lab., TN (USA). 9 May 1989. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017389/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report describes progress made by the International Commission on the Hydrology of Hazardous Waste in preparing a report on the subsurface disposal of liquid hazardous waste and on the development of new initiatives for the commission. Also contained in the trip report are summaries of discussions held with RIVM staff regarding environmental issues in The Netherlands, which is experiencing a series of environmental pressures due to its high population, large numbers of animals, and low elevation. Details of discussions related to waste management (hazardous and radioactive), groundwater pollution and monitoring, air quality, and global change are included.

46973 (ORNL/FTR–3346) **[US low-level radioactive waste management facility design, construction, and operation]: Foreign trip report, July 22–30, 1989.** Van Hoesen, S.D.; Bolinsky, J. Oak Ridge National Lab., TN (USA). 2 Aug 1989. 18p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OR21400. Order Number DE89016791/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Martin Marietta Energy Systems, Inc., Team, consisting of representatives of the Engineering Division and Oak Ridge National Laboratory (ORNL), participated in a technology exchange program on French and US low-level radioactive waste (LLW) management facility design, construction, and operation. Meetings were held at the Agence National pour la Gestion des Dechets Radioactif (ANDRA) offices in Paris to review the designs for the new French LLW disposal facility, the Cente de Stockage de l'Aube (CSA), and the new ORNL LLW disposal project, the Interim Waste Management Facility (IWMF), and the results of the French LLW disposal facility cover experiment at St. Sauveur. Visits were made to the operating LLW disposal facility, the Centre de Stockage de la Manche (CSM), the LLW conditioning facilities at the La Hague Reprocessing Facility, and the St. Saueveur Disposal Cap Experiment to discuss design, construction, and operating experience. A visit was also made to the CSA site to view the progress made in construction of the new facility.

46974 (ORNL/TM–10968) **Mineralogical characterization of selected shales in support of nuclear waste repository studies: Progress report, October 1987–September 1988.** Lee, S.Y.; Hyder, L.K.; Baxter, P.M. Oak Ridge National Lab., TN (USA). Jul 1989. 36p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC05-84OR21400. Order Number DE89015650/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Environmental Sciences Division Publication No. 3225.

One objective of the Sedimentary Rock Program at the Oak Ridge National Laboratory has been to examine end-member shales to develop a data base that will aid in evaluations if shales are ever considered as a repository host rock. Five end-member shales were selected for comprehensive characterization: the Chattanooga Shale from Fentress County, Tennessee; the Pierre Shale from Gregory County, South Dakota; the Green River Formation from Garfield County, Colorado; and the Nolichucky Shale and Pumpkin Valley Shale from Roane County, Tennessee. Detailed micromorphological and mineralogical characterizations of the shales were completed by Lee et al. (1987) in ORNL/TM-10567. This report is a supplemental characterization study that was necessary because second batches of the shale samples were needed for additional studies. Selected physical, chemical, and mineralogical properties were determined for the second batches; and their properties were compared with the results from the first batches. Physical characterization indicated that the second-batch and first-batch samples had a noticeable difference in apparent-size distributions but had similar primary-particle-size distributions. There were some differences in chemical composition between the batches, but these differences were not considered important in comparison with the differences among the end-member shales. The results of x-ray diffraction analyses showed that the second batches had mineralogical compositions very similar to the first batches. 9 refs., 9 figs., 4 tabs.

46975 (ORNL/TM–11050) **Remote-handled transuranic solid waste characterization study: Oak Ridge National Laboratory.** Stewart, R.C.; Dickerson, L.S.; Joost, S.F.; Osucha, D.C. Oak Ridge National Lab., TN (USA). Jun 1989. 95p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OR21400. Order Number DE89015681/JAW. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

At Oak Ridge National Laboratory (ORNL) several facilities generate TRU waste. Since 1970, this waste has been stored in a retrievable manner on the Oak Ridge Reservation. However, the DOE master plan for TRU waste establishes a goal of ending interim storage and achieving permanent disposal of DOE TRU waste at the Waste Isolation Pilot Plant (WIPP), a geologic repository for TRU waste located about 2000 ft underground in a salt formation near Carlsbad, New Mexico. ORNL's remote-handled (RH) TRU waste [waste with surface dose rates (of its container) greater then 200 mrem/h] will require processing before receiving certification for shipment to WIPP. The objective of this solid waste characterization task is to accurately characterize RH TRU and SC TRU solid waste currently stored at ORNL to assist in planning the facility design for WHPP. Execution of the solid waste characterization task objective will satisfy the following two goals. 8 refs., 11 figs., 8 tabs.

46976 (ORNL/TM–11141) **Separation of depleted uranium fragments from gun test catchments: Phase 1, Catchment system evaluation and separations methods.** Wichner, R.P.; Khan, A.A.; Hoegler, J.M. Oak Ridge National Lab., TN (USA). Jun 1989. 128p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. Order Number DE89015674/JAW. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

Phase 1 activities are described for a task entitled "Catchment and Separation of Depleted Uranium Pellets," sponsored by the Air Force Engineering Services Center, Tyndall Air Force Base. The purpose of the work is the development of improved means for separating depleted uranium projectile fragments from target materials, principally sand. Phase 1 activities included (1) literatures review of separations technology, (2) site visits, (3) analysis and description of current operations, (4) sampling and analysis of target sand material, and (5) evaluation of alternatives to sand as the bullet stopping medium. As a result of this study, several alternatives to the current separations and disposal procedures are identified which would result in significant cost savings over the life of the test facility. The most significant factor is an improved screening procedure which increases the usable sand life and decreases disposal costs. No suitable alternatives to sand as the bullet stopping medium were found that satisfied technical and operational constraints existing at the current test facility. 18 refs., 23 figs., 23 tabs.

46977 (PER–165) **Geohydrological appraisal of the Vaalputs radioactive waste disposal facility in Namaqualand, South Africa.** Levin, M. Atomic Energy Corp. of South Africa (Pty) Ltd., Pretoria (South Africa); University of the Orange Free State, Bloemfontein (South Africa). Oct 1988. 290p. Order Number DE90601295/JAW. Available from NTIS (US Sales Only), PC A13/MF A01 - OSTI; INIS.

Contains a geological map of the Vaalputs national radioactive waste disposal facility, northwestern Cape, South Africa, compiled by M.A.G. Andreoli, N.J.B. Andersen, E. Raubenheimer, N. Niemand and M. Levin.

The Vaalputs National Radioactive Waste Disposal Facility is located on the Bushmanland Plateau. The disposal site is situated close to the junction of three river basins. All the parameters neccessary were obtained, and methodology developed, to monitor the moisture content of the clay layers underlying the disposal site. Environmental isotope studies established the percolation only reached 3,5m in depth during the past 50 years. The depth was confirmed by neutron meter measurements. The depth to the piezometric surface below the site is, on average, 55m. Ground water is confined to both vertical and horizontal fractures and weathered joints. The high transmissivity of water-bearing structures below the site and the flat piezometric surface are seen as advantageous. In the event of a serious leak and radionuclides reaching the ground water, sustained pumping may lower the piezometric surface creating a basin effect and preventing contamination from reaching private boreholes. Regional hydrogeochemical studies have confirmed that regional flow away from the disposal site toward the Koa drainage is slow and nearly stagnant. The geochemical environment is favourable for attenuating any radionuclide leakage. 1 map, 93 figs., 47 tabs., 158 refs.

46978 (PNL–6989) **Leaching of ^{14}C and ^{36}Cl from irradiated French graphite.** Gray, W.J.; Morgan, W.C. Pacific Northwest Lab., Richland, WA (USA). Aug 1989. 29p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-76RL01830. Order Number DE89016581/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The leach rates of ^{14}C and ^{36}Cl were measured on solid cylindrical samples prepared from irradiated graphite blocks supplied by the French Commissariat a l'Energie Atomique (CEA). Static leach tests were conducted in deionized water at 20°C for 13 weeks. The graphite samples were completely submerged in the water, and the entire volume of water was changed and analyzed at weekly

intervals for the first three weeks and biweekly thereafter. Large differences in the leach rates of both ^{14}C and ^{36}Cl were observed between samples machined from the different blocks. In general, the leach rates were much higher than those measured in an earlier study with graphite obtained from a block removed from one of the Hanford reactors. The data from this study are compared with those from the previous study using the Hanford-reactor graphite. Implications of the data from both studies regarding possible rate-limiting mechanisms are discussed. 4 refs., 8 figs., 3 tabs.

46979 (PNL-SA–16788) **Measurement methods for low-level ^{129}I determinations.** Brauer, F.P. Pacific Northwest Lab., Richland, WA (USA). Aug 1989. 16p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. (CONF-890854–10: 11. annual DOE low level waste management conference, Pittsburgh, PA (USA), 22-24 Aug 1989). Order Number DE89016819/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The best methods for concentration measurements of low levels of ^{129}I and other very long-lived radionuclides present in nuclear wastes are based on techniques which do not require the measurement of radiation from the radionuclide. Radiochemical ^{129}I analyses based on chemical separations and counting require high radionuclide purity, have limited capability for checking the radionuclide purity, and have low sensitivity as a result of low ^{129}I specific activity. Other more selective and sensitive measurement methods developed and applied to ^{129}I analyses are neutron activation analysis (NAA), thermal emission negative ion mass spectrometry (AMS). These methods are at least a factor of 1,000,000 more sensitive than beta, x-ray, or gamma-ray counting methods. They are also very specific. All the methods require iodine separation from the sample prior to measurement but the more sensitive methods can use smaller sample sizes. A chemical separation method based on sample combustion, iodine trapping, and iodine purification is described. Iodine separations have been performed on a variety of solid, liquid, and off-gas waste samples. The measurement methods for the separated iodine are compared for application to low-level waste analyses. The NAA, TEMS, and AMS techniques have similar ^{129}I detection limits. Measurements by more than one method can be used to enhance quality assurance. The mass measuring instrument are also usable for C-14 and Tc-99 determinations on waste samples. 16 refs., 6 figs., 2 tabs.

46980 (PNL-SA–16832) **Studies on spent fuel dissolution behavior under Yucca Mountain repository conditions.** Wilson, C.N.; Bruton, C.J. Pacific Northwest Lab., Richland, WA (USA). Jul 1989. 19p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC06-76RL01830;W-7405-ENG-48. (CONF-890421–11: 91. annual meeting of the American Ceramic Society, Indianapolis, IN (USA), 23-27 Apr 1989). Order Number DE89017242/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Nuclide concentrations measured in laboratory tests with PWR spent fuel specimens in Nevada Test Site J-13 well water are compared to equilibrium concentrations calculated using the EQ3/6 geochemical modeling code. Actinide concentrations in the laboratory tests reach steady-state values lower than those required to meet Nuclear Regulatory Commission (NRC) release limits. Differences between measured and calculated actinide concentrations are discussed in terms of the effects of temperature (25°C to 90°C), sample filtration, oxygen fugacity, secondary phase precipitation, and the thermodynamic data in use. The concentrations of fission product radionuclides in the laboratory tests tend to increase continuously with time, in contrast to the behavior of the actinides. 11 refs., 5 figs., 4 tabs.

46981 (PNL-SA–16877) **Application of the quasi-stationary state approximation to interpret water-rock interactions in open hydrothermal systems.** Arthur, R.C. Pacific Northwest Lab., Richland, WA (USA). Aug 1989. 9p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC06-76RL01830. (CONF-890867–2: 6. international symposium on water-rock interaction, Malvern (UK), 3-9 Aug 1989). Order Number DE89016818/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Theoretical considerations and data from experiments using flow-through autoclaves confirm that water-rock interactions in open systems can be interpreted using kinetic reaction-path calculations, provided the experimental system approximates a stationary state in terms of invariant porosity, permeability and reactant surface areas. 10 refs., 1 fig., 1 tab.

46982 (PNL-SA–16884) **Performance assessment on grouted double-shell tank waste at Hanford.** Mitchell, D.H.; McNair, G.W.; Allison, J.M. Pacific Northwest Lab., Richland, WA (USA). Aug 1989. 14p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. (CONF-890854–11: 11. annual DOE low level waste management conference, Pittsburgh, PA (USA), 22-24 Aug 1989). Order Number DE89016821/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The low-level fraction of liquid waste stored in double-shell tanks at Hanford will be solidified in a cementitious matrix (grout) and disposed in subsurface vaults. This paper discusses activities related to the preparation of a site-specific performance assessment. A draft performance assessment has been prepared for the planned grout disposal system at Hanford using site-specific data. The assessment estimates the incremental increase in the dose to future populations who, after loss of institutional control at the site, use groundwater downgradient of the disposal site. Increases in nonradiological species in water from a hypothetical well are also estimated. Two-dimensional transport models were used to estimate contaminant concentrations in groundwater. Based on diffusional release from the waste package, the projected radiological dose to an individual on a hypothetical farm using water from a well at the disposal facility boundary is estimated at less than one percent of the 25 mrem/yr standard. Technetium accounted for about 95% of the dose. Nitrate was the principle chemical contaminant at 0.3% to 0.5% of apportioned drinking water standards. Sensitivity studies on various parameters are in progress. This performance assessment will be updated as additional data become available. 16 refs., 2 figs., 2 tabs.

46983 (SAND–88-2744) **Computed and measured responses of a thick-walled hollow cylinder of salt subjected to both homogeneous and inhomogeneous loading.** Morgan, H.S.; Wawersik, W.R. Sandia National Labs., Albuquerque, NM (USA). Jun 1989. 15p. Sponsored by U.S. DOE Radioactive Waste Management. DOE Contract AC04-76DP00789. (CONF-890628–7: 30. US symposium on rock mechanics, Morgantown, WV (USA), 19-22 Jun 1989). Order Number DE89014354/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The present evaluations are based on comparisons of measurements on the hollow cylinders with predictions from three different constitutive models for rock salt. The three models are (1) an elastic power-law secondary creep (ESC) model, (2) a revision of the ESC (RESC) model with greatly reduced elastic moduli but unchanged creep parameters, and (3) a unified creep plasticity (UCP) model. The ESC model produced the predictions that differed from the Waste Isolation Pilot Plant (WIPP) in situ measurements by the factor-of-three or more. The modulus reductions in the RESC model are empirical adjustments that produced matching closures and closure rates with the WIPP measurements collected over less than five years. The UCP model yielded closures that were substantially higher than the ESC predictions but still less than the in situ measurements. At the same time, the UCP model produced closure rates in good agreement with the data. 12 refs., 5 figs., 1 tab.

0530 Environmental Aspects

Refer also to citation(s) 46958, 46965, 46968, 46969, 46970, 46971, 46972, 46973, 46974, 46975, 46977, 46978, 46979, 46980, 46982, 46983, 47000, 47001, 47003, 47004, 47005, 47959, 48027

46984 (ANSTO/E–675) **Radium and heavy metal transport beneath an abandoned uranium tailings dam.** Jeffery, J.J.; Sinclair, G.; Lowson, R.T. Australian Nuclear Science and Technology Organisation, Lucas Heights (Australia). Sep 1988. 17p. Order Number DE90601420/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

An abandoned uranium tailings dam at Moline in the Northern Territory of Australia was the site of a study to assess the movement of potentially toxic elements from tailings into subsoil. The tailings at Moline were first laid down in 1959 and have since been

leached by prevailing rainfall. Sixteen sampling sites were selected to give a good representation of the dam. At each site, a trench was excavated through the tailings and into the subsoil, then samples of subsoil were taken at 10 cm intervals down to a depth of 50 cm. A sample of the tailings overlying the tailings-subsoil interface was also taken. Samples were analysed for radium, uranium, copper, zinc, and lead. At most sites there was only minor accumulation of these elements in the 0-10 cm subsoil layer immediately below the interface, with concentrations typically one or two orders of magnitude less than the concentrations in overlying tailings. Below 10 cm, the concentrations were typically at or close to background concentrations.

46985 (DOE/RL–89-22) **Supplemental information for a notice of construction for the Fueled Clad Fabrication System, the Radioisotope Power Systems Facility, and the Fuel Assembly Area.** USDOE Richland Operations Office, WA (USA). Aug 1989. 131p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930. Order Number DE89017341/JAW. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

This "Notice of Construction" has been submitted by the US Department of Energy-Richland Operations Office (P.O. Box 550, Richland, Washington 99352), pursuant to WAC 402-80-070, for three new sources of radionuclide emissions at the Hanford Site in Washington State (Figure 1). The three new sources, the Fueled Clad Fabrication System (FCFS) the Radioisotope Power Systems Facility (RPSF) and the Fuel Assembly Area (FAA) will be located in one facility, the Fuels and materials Examination Facility (FMEF) of the 400 Area. The FMEF was originally designed to provide for post- irradiation examination and fabrication of breeder reactor fuels. These FMEF missions were cancelled before the introduction of any fuel materials or any irradiated material. The current plans are to use the facility to fabricate power supplies to be used in space applications and to produce Fast Flux Test Facility (FFTF) fuel and target assemblies. The FCFS and the RPSF will produce materials and assemblies for application in space. The FAA project will produce FFTF fuel and target assemblies. The FCFS and the RPSF will share the same building, stack, and, in certain cases, the same floor space. Given this relationship, to the extent possible, these systems will be dealt with separately. The FAA is a comparatively independent operation though it will share the FMEF complex.

0540 Health and Safety

Refer also to citation(s) 46985, 47141, 47148

46986 (CONF-881054–Vol.3, pp. 697-708) **In situ technologies for site remediation.** Ghassemi, M. (URS Consultants, Inc., Long Beach, CA (USA)). Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 3.* Order Number DE89014702/JAW. Available from NTIS, PC A14/MF A01.

In situ treatment of waste and soil at contaminated sites offers an alternative to the traditional approaches to site remediation involving excavation and disposal or onsite isolation. This paper provides an overview of the capabilities and limitations of some of the leading in situ technologies for site remediation. The In Situ Detoxifier is presented as an example of innovative system potentially capable of implementing a range of in situ treatment.

46987 (CONF-881054–Vol.3, pp. 967-976) **ORNL (Oak Ridge National Laboratory) implementation of New Health and safety requirements (DOE (Department of Energy) Order 5480.11).** Abercrombie, J.S. (Oak Ridge National Lab., TN (USA)). Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 3.* Order Number DE89014702/JAW. Available from NTIS, PC A14/MF A01.

New mandates in radiological protection outlined in DOE Order 5480.11, include changes in the methodology for determining total radiation dose, ALARA program accountability, monitoring requirements, and standards for public entrance into controlled areas. The new order places distinct requirements concerning training at all DOE facilities. Radiation protection training requirements are addressed, including the effective communication of operations changes to all employees. This paper details the endeavors underway at ORNL in designing, developing, and delivering the training required by the new mandates. Strategies taken to reach the intended goals are explained. Efforts involve the design and implementation of the above mentioned radiation protection programs, a job-specific ALARA instructional package, and a Risk-Based Philosophy program matched to operational changes.

46988 (CONF-881054–Vol.3, pp. 977-988) **Training requirements for preparing hazardous waste site workers for involvement with mixed waste.** Waite, D.A. (Envirosphere Co., Issaquah, WA (USA)); Mantooth, D.S. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 3.* Order Number DE89014702/JAW. Available from NTIS, PC A14/MF A01.

In the future, it is highly probable that many more of the site remediation jobs will involve radioactive materials, presenting the existing trained workforce with new challenges. The purpose of this paper is to examine the training that the present workforce needs to supplement their knowledge and experience to be properly prepared to work with radioactive materials when the need arises. The REM site worker characterization data used as the basis of this discussion were developed through a survey of education, experience, and supplemental training information for Ebasco and Envirosphere hazardous waste site workers. These individuals are categorized in terms of their academic degrees and disciplines; their experience with hazardous materials, personnel protection concepts, and instrumentation; and supplemental training. The minimum requirements for working with mixed nuclear and chemically hazardous, or mixed wastes are proposed in terms of the three characteristics referred to earlier in the personnel characterization activity: education, experience and training. These requirements are derived on the basis of experience, not regulatory guidance, and the rationale for each component is suggested. The identification of additional training needed to prepare the REM workers for involvement with mixed waste is accomplished through the comparison of the requirements with the existing capabilities. These comparisons are done on the basis of the same three characteristics that are utilized in the previous sections of this discussion. The paper is concluded with suggestions pertaining to the most efficient and cost effective means by which these suggestions are tailored to the circumstances that might exist within various companies in terms of the capabilities to conduct the training, and the financial and time constraints involved.

46989 (CONF-881054–Vol.3, pp. 1001-1016) **University programs in waste management research, education, and training.** Gumnick, J.L. (Oak Ridge Associated Universities, TN (USA)); Wohlpart, A. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. DOE Contract AC05-76OR00033. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 3.* Order Number DE89014702/JAW. Available from NTIS, PC A14/MF A01.

Oak Ridge Associated Universities (ORAU) began in 1946 as the Oak Ridge Institute of Nuclear Studies with the mission of training practicing scientists and engineers by transferring the advances of the Clinton Laboratories (now Oak Ridge National Laboratory) to the private sector. ORAU has continued to promote closer university ties with DOE (Department of Energy) laboratories by developing and managing programs directed at the entire academic community. In this presentation, the authors will describe ongoing and planned activities designed to increase the participation of universities in waste management, to assist in the transfer of applied research findings, to assess the capabilities of educational institutions to fill shortages of essential waste management professionals, and to develop and implement required professional training programs. Research activities in hazardous waste research and management will be described.

46990 (CONF-881054–Vol.4, pp. 1079-1090) **Characterization of sediment in a leaching trench RCRA (Resource Conservation and Recovery Act) site.** Zimmerman, M.G. (Westinghouse Hanford Co., Richland, WA (USA)); Kossik, C.D. Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

Hazardous materials potentially were disposed of into a pair of leaching trenches from 1975 until Resource Conservation and Recovery Act (RCRA) regulations were imposed in 1985. These leaching trenches now are used for disposal of nonhazardous process water. The typical effluent (approximately 3 million gal/d) consisted of water with trace quantities of laboratory, maintenance, and fuel fabrication process chemicals. The largest constituent in the waste stream was uranium in low concentrations. This paper describes the project used to analyze and characterize the sediments in and below the leaching trenches. Two phases of sediment sampling were performed. The first phase consisted of taking samples between the bottom of the trenches and groundwater to locate contamination in the deep sediments under the trenches. To accomplish this sampling, a series of wells were drilled, and samples were obtained for every five feet in depth. The second phase consisted of samples taken at three depths in a series of positions along each trench. Sampling was completed to determine contamination levels in the shallow sediments and loose material washed into the trenches from the process sewer system. The project results were that no measurable contamination was found in the deep sediments. Measurable contamination from metals, such as chromium and nickel, was found in the shallow sediments. The primary contaminant in the shallow sediments was uranium. The concentration of contaminants decreased rapidly to near-background levels at shallow depths below the bottoms of the trenches.

46991 (CONF-881054–Vol.4, pp. 1091-1102) **Selection and design of remedial action for the high priority sites at the Rocky Flats Plant.** Anderson, M.A. (Roy F. Weston, Inc., Lakewood, CO (USA)); Greengard, T.C. Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

The Rocky Flats Plant 881 Hillside is an area formerly used for chemical disposal and drum storage of hazardous and radioactive mixed waste. Leaking drums and chemical disposal have resulted in volatile organic compound (VOC) contamination of ground water to levels up to 30,000 ug/1. These levels, and the proximity of the area to a major surface water drainage leading off site (ground-water discharge area) triggered the RI/FS process. This paper summarizes results of the remedial investigation and focuses on the alternatives evaluation for treatment of VOC-contaminated ground water collected from a french drain/withdrawal well system. Although a host of candidate treatment systems were considered, carbon adsorption, air stripping, ultraviolet (UV)/peroxide and UV/ozone were most cost effective. Factors considered in choosing UV/peroxide over the other systems were predicted performance, ability to meet effluent standards, reliability, air pollution considerations, mechanism of treatment, capital cost, and operation and maintenance costs. These factors are discussed in detail in the paper and include presentation of treatability study data and treatment performance data from existing full scale systems. Design details of the proposed ground-water collection and treatment system are also presented.

46992 (CONF-881054–Vol.4, pp. 1287-1298) **The role of risk assessment in remedial action cleanup programs (RACP): A case history.** Fessler, R.G. (Kaman Tempo, Santa Barbara, CA (USA)); Bergmann, W.R.; Greenberg, A.J. Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

A RACP (Remedial Action Cleanup Program) selects site cleanup criteria that protect human health and the environment and are cost effective. They generally use existing environmental standards and/or guidelines which include safe drinking water, RCRA groundwater protection, threshold limit values and air quality standards, and recommended soil cleanup level guidelines. If these are the only criteria used, the RACP may be more stringent and expensive than necessary. Another step, a risk assessment program, should then be considered in the cleanup decision process. A risk assessment uses chemical concentrations observed in soils, groundwater, and air to project their impact on human health and the environment. Toxicological data on human exposure to these concentrations (LD 50s and carcinogenic action levels) are used to assess risks to human health and the environment. The risk assessment also considers the probability of exposure. E.g., remedial programs at Superfund sites consider three criteria in order to assess risks to human health and the environment: (1) pathways of exposure, (2) population at risk, and (3) chemicals of concern. By eliminating or severely limiting the significance of any criteria, the site may no longer represent a significant risk. This paper presents a RACP case history where a risk assessment was needed to select a cost effective and environmentally acceptable cleanup program.

46993 (CONF-881054–Vol.4, pp. 1321-1330) **The Multimedia environmental pollutant assessment system (MEPAS) user-friendly shell.** Hoopes, B.L. (Pacific Northwest Lab., Richland, WA (USA)); Buck, J.W.; Friedrichs, D.L.; Aiken, R.J. Analysas Corp., Oak Ridge, TN (USA). 1988. DOE Contract AC06-76RL01830. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

Pacific Northwest Laboratory (PNL) has developed the Multimedia Environmental Pollutant Assessment System (MEPAS) to prioritize environmental issues based on their potential impact to public health. MEPAS is an objective, physics-based system that quantifies the relative risk to the surrounding population from radioactive and chemical constituents released to the environment. MEPAS uses generally accepted, independently peer-reviewed computer models that simulate constituent migration and fate from the source through designated transport pathways to important environmental receptors, where exposure and relative risk calculations are performed. PNL has provided support in implementing the MEPAS model by supplying an external code, called a shell, that simplifies model operation and execution. The MEPAS user-friendly shell is a menu-driven application written for IBM PC-compatible systems to provide simplified data input, access, modification, and preparation of site data required to estimate potential environmental hazards using MEPAS.

46994 (CONF-881054–Vol.4, pp. 1381-1392) **Development of site remediation technologies in European countries.** Nunno, T.J. (Alliance Technologies Corp., Bedford, MA (USA)); Hyman, J.A.; Pheiffer, T. Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

Site remediation is a pressing issue in European countries due to limited availability of land. Therefore, much progress is being made in the development of effective technologies for remediating contaminated sites. The purpose of this program was to investigate the most successful and innovative technologies for potential application into US markets. This EPA-sponsored project was based on a 9-month research effort which identified 95 innovative technologies in use or being researched in foreign countries. The most promising technologies were studied in-depth through personal interviews with the engineers who research and apply these technologies, and tours of laboratory models and full-scale installations. The most successful full-scale technologies investigated were developed in Holland, West Germany and Belgium. These technologies include vacuum extraction of hydrocarbons from soil, in situ washing of cadmium-polluted soil, rotating biocontractors for treating pesticides in ground water, high-temperature slagging incineration of low-level radioactive wastes, in situ steam stripping, and a number of landfarming and soil washing operations. The paper provides description of 13 site remediation techniques that have shown such promise in laboratory studies or in practice to warrant consideration of their use in the US.

46995 (CONF-881054–Vol.5, pp. 1543-1551) **Underground storage tanks: State regulations and compliance strategies.** Robinson, J.E. (Earth Technology Corp., Alexandria, VA (USA)). Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 5.* Order Number DE89014704/JAW. Available from NTIS, PC A13/MF A01.

In an effort to resolve underground storage tank (UST) management problems, several states and localities have moved ahead of EPA in the promulgation of UST regulations. Developed independently, these regulations represent different strategies for ensuring compliance: from an extensive set of permitting requirements that allow for the implementation of site-specific control measures to a uniform set of technical and operational requirements that vary according to installation date. For the tank owner, complying with these regulations can be a time-consuming and frustrating endeavor. However, during the course of several environmental audits of similar facilities in different states, useful strategies were observed or developed that enabled facilities to respond more effectively to requirements: these included computerization of files, designation of tank custodians, installation of low-maintenance equipment, and increased use of above-ground tanks. Of special additional interest was the wide variation in costs for similar tank services quoted by both private and government sources. These strategies are coupled with general observations on the efficacy of the various regulatory approaches to provide a field view that may be useful to tank owners and others involved in underground tank management and evaluation.

46996 (CONF-881054–Vol.5, pp. 1553-1562) **Problems mixed wastes pose in implementing RCRA (Resource Conservation and Recovery Act) requirements.** White, W.T. (Dames and Moore, Atlanta, GA (USA)). Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 5.* Order Number DE89014704/JAW. Available from NTIS, PC A13/MF A01.

Inclusion of Mixed Wastes, wastes which are both radioactive and hazardous, into the RCRA (Resource Conservation and Recovery Act)-regulated wastes poses some problems in establishing procedures that are both safe in terms of handling radioactive substances and which are responsive to the requirements of RCRA, particularly as these requirements are interpreted in several RCRA procedural guidelines. As stated in RCRA, safe handling of radioactive waste takes precedence over RCRA requirements. However, the applicant must still implement RCRA procedures where possible. To date there are no real guidelines on how to treat RCRA requirements which are contrary to the safe handling of radioactive wastes. Examples of such problems are the classification of facilities, inspection procedures, emergency procedures, and closure requirements. These problems have been addressed by the Savannah River Plant in several RCRA operating permit applications and post-closure permit applications. Examination of incompatibilities addressed by these applications provides insight into the options available for permitting Mixed Waste facilities.

46997 (CONF-881054–Vol.5, pp. 1563-1574) **EPA (Environmental Protection Agency) and state authority over DOE (Department of Energy) groundwater radionuclides.** Cudworth, J.A. (NUS Corp., Aiken, SC (USA)); Bauer, J.D. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 5.* Order Number DE89014704/JAW. Available from NTIS, PC A13/MF A01.

This paper summarizes the extent of US Environmental Protection Agency (EPA) and State authority to regulate radionuclides in the groundwater beneath US Department of Energy (DOE) facilities. Radioactively contaminated groundwater is a potential problem for many DOE facilities, but the EPA and the States must establish legal authority before requiring remedial action or regulating discharges. While regulatory authority with respect to nonradioactive constituents has been clearly established, the same is not true for radioactive constituents. The question of facility radionuclide regulation entails issues such as sovereign immunity, Atomic Energy Act authority, the definition of federally permitted release, and the general lack of a Federal groundwater protection program. This paper addresses these issues through a review of statutes, court opinions, Congressional activities, EPA and State authority (for each state having a DOE operations office within its jurisdiction), and DOE field office experience. Experience at the DOE Savannah River Operations Office, Aiken, South Carolina, is highlighted.

46998 (CONF-881054–Vol.5, pp. 1575-1583) **Alternate concentration limits for the UMTRA (Uranium Mill Tailings Remedial Action) Project.** Bierley, D.A. (Roy F. Weston, Inc., Albuquerque, NM (USA)). Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 5.* Order Number DE89014704/JAW. Available from NTIS, PC A13/MF A01.

The Department of Energy's (DOE) Uranium Mill Tailings Remedial Action (UMTRA) Project is charged with the cleanup of 24 inactive uranium mill sites in ten different states. The EPA recently issued proposed groundwater standards (52 FR 36000, September 24, 1987) as a result of a Tenth Circuit Court of Appeals remand. Groundwater protection standards (as per 40 CFR 264.92) for each of the sites are an integral part of the new regulations. The project has the option to apply for background concentrations, maximum concentration limits (MCLs) or alternate concentration limits (ACLs) as part of the components of the site specific groundwater protection standards. The variety of information and discussion needs for obtaining ACLs for the UMTRA Project sites include risk assessment, groundwater hydrology, environmental issues, and NRC and state involvement. One of the important aspects in any UMTRA ACL demonstration is the concept of as low as reasonably achievable (ALARA). This paper will discuss the various issues and information requirements for obtaining ACLs for the UMTRA Project sites.

46999 (CONF-881054–Vol.5, pp. 1649-1668) **Data and information management system for the ORNL (Oak Ridge National Laboratory) Remedial Action Program.** Voorhees, L.D. (Oak Ridge National Lab., TN (USA)); Hook, L.A.; Gentry, M.J.; Owen, P.T.; Newman, K.A.; McCord, R.A.; Faulkner, M.A.; Bledsoe, J.L. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 5.* Order Number DE89014704/JAW. Available from NTIS, PC A13/MF A01.

A Remedial Action Program (RAP) was established in FY 1985 at Oak Ridge National Laboratory (ORNL) to provide corrective measures at areas contaminated with radioactive and/or hazardous chemical wastes. To achieve this goal, numerous and varied studies are being conducted to characterize the waste disposal sites. Environmental data collected in support of other programs at ORNL are also of use to RAP. Collectively, these studies are generating a voluminous amount of data on a scale unprecedented for ORNL. A computerized Data and Information Management System (DIMS) was developed to (1) provide a centralized repository for data pertinent to RAP and (2) provide support for the investigations and assessments leading to the long-term remediation of contaminated sites and facilities. The current DIMS and its role in supporting RAP are described. The DIMS consists of three components: (1) the Bibliographic Data Base, (2) the Records Control Data Base, and (3) the Numeric Data Base. This paper/poster emphasizes the Numeric Data Base, including its development and organization, and also summarizes the status of other activities associated with management and use of such data (i.e., bibliographic information, records control, geographic information, and quality assurance). The types of data currently available have been summarized, and a synopsis of the contents of the RAP numeric data base has been compiled in a menu-driven program available on PC diskettes. The synopsis will be demonstrated at the conference.

47000 (DOE/SSDP–0067) **Contaminated concrete scabbling at the Shippingport Station Decommissioning Project.** Bauer, R.G. Westinghouse Hanford Co., Shippingport, PA (USA). [1989]. 13p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930;AC06-84RL10421. (CONF-890604–19: Annual meeting

of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989). Order Number DE89016830/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

At turnover, there were several areas in the plant where radioactive contamination was entrained in concrete surfaces. The walls and floors of the refueling canal representing the primary source of contaminated concrete at the SSDP. The residual contamination levels in the refueling canal were low and it was not certain that concrete decontamination would be required, as the site release criteria had not been formally established. The primary isotope of concern was Co-60. The mean concentration of radioactivity entrained in the concrete surface was measured at 11,200 pCi/gm. Exposure rates adjacent to the walls averaged 3 mRem/hr. The technical specification for concrete decontamination was initially prepared as a contingency measure in parallel with the development of the site release criteria. The Decommissioning Operations Contractor (DOC) prepared this specification to be utilized if the final approved release criteria required it; or, to avoid future project delays in the absence of an approved site release criteria. With the receipt of DOE guidance for development of the site release criteria (100 mrem/yr to the maximum exposed individual), it was determined that the refueling canal did not meet the occupancy scenario requirements. The DOC subsequently issued the bid package and awarded the subcontract for the removal of contaminated concrete. This summary highlights some of the management decisions and engineering considerations for the removal of the contaminated concrete at the SSDP. The paper will give further background to the engineering decisions, concrete decontamination practices and experience. 2 refs.

47001 (DOE/SSDP–0073) **Marine transportation and burial of the Shippingport Reactor Pressure Vessel/Neutron Shield Tank (RPV/NST) package.** Coughlin, P.J. General Electric Co., Shippingport, PA (USA). [1989]. 19p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930;AC06-84RL10421. (CONF-890604–17: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989). Order Number DE89016835/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Shippingport Station Decommissioning Project (SSDP) is a Department of Energy (DOE) project to dismantle the Shippingport Atomic Power Station. One of the more significant and challenging technical aspects of the project, which is being managed for DOE by GE-Nuclear Energy, is the marine transport of the Reactor Pressure Vessel (RPV) and its associated Neutron Shield Tank (NST) to the government owned Hanford Reservation near Richland, WA. 2 refs.

47002 (DOE/SSDP–0070) **Shippingport: Overall project progress.** Crimi, F.P. General Electric Co., Shippingport, PA (USA). Nuclear Energy Business Operations. 1989. 17p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930;AC06-84RL10421. (CONF-890604–18: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989). Order Number DE89016836/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Shippingport Atomic Power Station (SAPS) consisted of the Nuclear Steam Supply Steam and associated radioactive waste processing systems, which were owned by the United States Department of Energy (DOE), and the Balance of Plant, owned by the Duquesne Light company. The station is located at Shippingport, Pennsylvania, on seven acres of land leased by DOE from Duquesne Light Company. The Shippingport Station Decommissioning Project (SSDP) is being performed under contract to the DOE by the General Electric Company and its preselected subcontractor, MK-Ferguson Company, as the Decommissioning Operations Contractor (DOC). This paper describes the decommissioning work which has been accomplished since July 1988, and the project's cost and schedule status. 4 refs.

47003 (EGG-M–89176) **Corrective action investigation of a mixed waste contaminated percolation pond.** Van Deusen, L.C.; Monnot, D.R.; Hull, L.C.; Davis, K.D.; Weiler, F.H.; Sheldon, D.E. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 7p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-8905203–1: Workshop on the management of radioactively contaminated sites, Albuquerque, NM (USA), 3-5 May 1989). Order Number DE89016355/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Idaho National Engineering Laboratory (INEL), located in southeast Idaho and operated by the Department of Energy (DOE), has had the largest number of nuclear reactors during its lifetime of any location in the United States. The Test Reactor Area (TRA), one facility within the INEL, has been the home of three major test reactors, one of which is still operational. The TRA Warm Waste Pond is a three-celled percolation pond that has received waste from these reactor operations since 1952. The pond is estimated to have received over 27,700 lbs of chromium in addition to about 5.2 $\times$ 10^4 curies of radioactive materials. Because of known migration of contaminants to a perched-water zone, the pond is scheduled for corrective actions under a Resource Conservation and Recovery Act (RCRA) Consent Order and Compliance Agreement with Region X, Environmental Protection Agency (EPA). The pond will probably be included on the National Priority List by the spring of 1989. Field investigations were initiated in 1987 and continued in 1988 to pursue possible corrective or remedial actions. This paper describes the efforts to date, including a description of the unique problems and physical restrictions associated with sampling the pond while it is in use and sampling through the gravel and cobblestones that line the pond. 6 refs., 1 fig.

47004 (ORNL/TM–11172) **An approach to remedial action decisions on sites which are marginally contaminated with Radium-226.** Williams, L.R. Oak Ridge National Lab., TN (USA). Jun 1989. 39p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE89016918/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Current standard of the US Environmental protection Agency (EPA) for contamination of soil with uranium mill tailings include the requirements that the average Ra-226 concentrations over a 100-m^2 area should not exceed 5 pCi/g above background in the top cm of soil (40 CFR Part 192). The determination of compliance of a property with this portion of the EPA standard is often based on the Ra-226 concentration in one or two composite samples. When the decision is based on such a small sample size, the usual approach may falsely include or falsely exclude large numbers of properties for remedial action. This report illustrates how a preliminary determination of certain general statistical characteristics of the contamination may be most efficiently applied to reduce the number of erroneous decisions and associated costs concerning compliance with the EPA standard. Two points of decision are addressed: (1) whether a contaminated property should be included in a remedial action program and (2) whether a property that has undergone remedial action has been sufficiently decontaminated. The conclusions of this study apply generally (but perhaps not quantitatively) to determination of compliance with the EPA standard for Ra-226 in subsurface soil or that for radon daughters in air, for example, or with a great many regulatory limits for other contaminants. 4 refs., 7 figs., 5 tabs.

0550 Safeguards, Inspection, and Accountability

Refer also to citation(s) 47247

47005 (CONF-8909110–4) **Total quality management – Remedial actions planning program.** Petty, J.L.; Horne, T.E. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA). 1989. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OR21400. From 16. annual conference of the American Society for Quality Control; Fort Lauderdale, FL (USA); 17-20 Sep 1989. Order Number DE89014081/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This paper describes the management approach being taken within the Hazardous Waste Remedial Actions Program (HAZWRAP) Support Contractor Office (SCO) to ensure quality of services in a highly competitive waste management environment. An overview is presented of the contractor support role assigned to Martin Marietta Energy Systems, Inc., by the Department of Energy (DOE) national program for managing hazardous waste. The HAZWRAP SCO mission, organizational structure, and major programs are outlined, with emphasis on waste management planning for the DOE Work for Others (WFO) Program. The HAZWRAP SCO provides waste management technical support, via interagency agreements between

DOE and various Department of Defense (DOD) agencies for DOD sponsors planning remedial response actions. The remainder of the paper focuses on how the concept of Total Quality Management is applied to the HAZWRAP Remedial Actions Planning (RAP) Program. The management challenge is to achieve quality on a "system" basis where all functional elements of program management synergistically contribute to the total quality of the effort. The quality assurance (QA) program requirements applied to the RAP Program and its subcontractors are discussed. The application of management principles in the areas of program management, procurement, and QA to achieve total quality is presented. 3 refs.

47006 (DP-MS–89-46) **Automated data collection (ADC) extension of a generic computerized nuclear material accountability system.** Davis, J.M. Jr.; Biernacki, J.V. Westinghouse Savannah River Co., Aiken, SC (USA). [1989]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-890736–68: 30. annual meeting of the Institute of Nuclear Materials Management, Orlando, FL (USA), 9-12 Jul 1989). Order Number DE89017855/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An automated data collection (ADC) application provides near-real-time accountability (NRTA) for the New Special Recovery (NSR) facility. This paper discusses the software design of the ADC implementation. NSR processes plutonium scrap and has the analytical instrumentation, distributed process control, and data acquisition systems needed for NRTA. The ADC is a NSR-specific extension of the manual data entry Nuclear Materials Accountability System (NucMAS). The ADC reads measurement and material transfer data from the computers on the network. The ADC transforms this data into accountability events/transactions and maintains the current book inventory for NSR. The ADC updates the same NucMAS data tables that are updated by clerk-entered accountability events/transactions for the rest of FB-Line material balance area (MBA). The ADC uses a data driven approach in its design. The rules that govern the translation of network information into accountability events/transactions are stored as data in configuration tables. This approach results in a system that is configurable and maintainable. 2 figs.

47007 (IWGFPT–31, pp. 73) **Non-destructive burnup determination of spent fuel in the framework of nuclear material safeguards.** Schenkel, R. (Commission of the European Communities (Luxembourg). Directorate of Euratom Safeguards); Smith, B. International Atomic Energy Agency, Vienna (Austria). International Working Group on Water Reactor Fuel Performance and Technology. May 1989. (CONF-8806392–: IAEA technical committee meeting on burnup determination of water reactor fuel, Karlsruhe (Germany, F.R.), 13-16 Jun 1988). In *Burnup determination of water reactor fuel. Proceedings of a technical committee meeting held in Karlsruhe, 13-16 June 1988.* Order Number DE90601639/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

Published in summary form only. 7 refs.

47008 (LA-UR–89-1347) **Nuclear fission and nuclear safeguards: Common technologies and challenges.** Keepin, G.R. Los Alamos National Lab., NM (USA). [1989]. 20p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-8904201–4: American Nuclear Society meeting, Gaithersburg, MD (USA), 25-28 Apr 1989). Order Number DE89016608/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Nuclear fission and nuclear safeguards have much in common, including the basic physical phenomena and technologies involved as well as the commitments and challenges posed by expanding nuclear programs in many countries around the world. The unique characteristics of the fission process – such as prompt and delayed neutron and gamma ray emission – not only provide the means of sustaining and controlling the fission chain reaction, but also provide unique "signatures" that are essential to quantitative measurement and effective safeguarding of key nuclear materials (notably ^{239}Pu and ^{235}U) against theft, loss, or diversion. In this paper, we trace briefly the historical emergence of safeguards as an essential component of the expansion of the nuclear enterprise worldwide. We then survey the major categories of passive and active nondestructive assay techniques that are currently in use or under development for rapid, accurate measurement and verification of safe-guarded nuclear materials in the many forms in which they occur throughout the nuclear fuel cycle. 23 refs., 14 figs.

0560 Legislation and Regulations

Refer also to citation(s) 46995, 46996, 46997, 47148

47009 (CONF-881054–Vol.5, pp. 1597-1608) **Trends in state and local regulations of the transportation of hazardous and radioactive materials.** Carnes, N. (Science Applications International Corp., Oak Ridge, TN (USA)). Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 5.* Order Number DE89014704/JAW. Available from NTIS, PC A13/MF A01.

State and local governments are taking an increasingly active role in all facets of hazardous and radioactive waste management. While historically the transportation of hazardous and radioactive materials has been pervasively regulated at the Federal level, States are increasing their legislative and regulatory activities in this area in response to public awareness and concerns. This trend presents classic constitutional problems associated with the power of the state vis-a-vis the powers of the Federal Government. For DOE and its contractors the issue is particularly thorny in light of the magnitude of DOE transportation activities and DOE policy regarding compliance with state and local regulations. This paper will highlight recent state activities and trends in state transportation regulations and the legal implications of this emerging State-Rights issue for hazardous and radioactive waste management in the public and private sector.

47010 (INIS-mf–11536) **Proposed Radiation Control Act: discussion paper.** New South Wales Dept. of Health, Sydney (Australia). 1989. 13p. Order Number DE90601750/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

The history and nature of the present NSW Radioactive Substances Act passed in 1957 is outlined. The direction of reform is suggested and some options for changes presented. These include the extension of controls to cover non-ionising radiation, the introduction of controls over the mining and milling of radioactive ores, and improved licensing provisions. Professional and public comment is sought.

07 ISOTOPE AND RADIATION SOURCE TECHNOLOGY

0701 Physical Isotope Separation

47011 (INIS-mf–11537, pp. 59) **Isotope separation in the vacuum arc centrifuge.** Evans, P.J. (Australian Nuclear Science and Technology Organisation, Lucas Heights (Australia)); Noorman, J.T.; Whichello, J.W.; Paoloni, F.J. Australian Inst. of Nuclear Science and Engineering, Lucas Heights (Australia). 1989. (CONF-8902130–: 17. AINSE plasma physics conference, Lucas Heights (Australia), 6-8 Feb 1989). In *17th AINSE plasma physics conference: conference handbook.* Order Number DE90600936/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

Abstract only.

0702 Radiation Sources

Refer also to citation(s) 46897

47012 (ANSTO/E–681) **Production of ultra-thin layers of ion-exchange resin and metallic silver by electrospraying.** Wylie, H.A. Australian Nuclear Science and Technology Organisation, Lucas Heights (Australia). Oct 1988. 28p. Order Number DE90601592/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Highly efficient radioactive sources for use in radioisotope metrology have been prepared on ultra-thin layers of electrosprayed

ion-exchange resin. The efficiency of these sources can be reduced for the purpose of radioactivity standardisation by coating them with conducting silver layers which are also produced by electrospraying. A description is given of improvements to the electrospraying methods, together with details of the rotating, oscillating source-mount turntable.

47013 (INIS-GB–199) **Scottish Universities Research and Reactor Centre annual report 1987-1988.** Whitley, J.E. Scottish Universities Research and Reactor Centre, Glasgow (UK). 1988. 90p. Order Number DE90601678/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

The Scottish Universities Research and Reactor Centre (SURRC) provides facilities for research in isotopic, nuclear and earth sciences and collaborates with Scottish University departments on a wide range of research topics. One of its main areas of work is the Isotope Geology Unit. This has worked with the Nuclear Medicine Unit on the application of enriched stable isotope tracers in the biological and clinical sciences. The measurement of radioactive isomers is applied to quaternary geology, archaeology, nuclear medicine, health physics, oceanography, atomospheric sciences, environmental chemistry, nuclear waste disposal and mathematical modelling of the environment. There are also radiocarbon dating facilities. The facilities and the research undertaken at the Centre in the year 1987-1988, the Centre's twenty-fifth year are summarized in this report. (U.K.).

47014 (INIS-mf–11997) **TEPOS workshop: Positron sources.** Giessen Univ. (Germany, F.R.). Strahlenzentrum. 1988. 21p. (In German). (CONF-8806415–: Workshop of the Strahlenzentrum of the Justus Liebig University Giessen: positron sources, Giessen (Germany, F.R.), 23-24 Jun 1988). Order Number DE90702759/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

The workshop discussed the production of high-intensity, low-energy positron beams (eV to MeV range), their applications, and the use of the TEPOS positron source of the LINAC at Giessen University. The eleven papers and the workshop were intended to foster cooperation among the various scientific research groups. Positron beams are used for atomic, solid state, and nuclear physical experiments. Some papers also discussed marginal aspects such as antihydrogen production, positron lines, and Bhabha scattering. (DG).

47015 (JAERI-M–88-260) **Reconstruction of Co-60 Irradiation Facility No.1.** Nakamura, Yoshiteru; Takada, Isao; Kaneko, Hirohisa; Hirao, Toshio; Haneda, Noriyuki; Mitomo, Shouichi; Tachibana, Hiroyuki; Yoshida, Kenzou. Japan Atomic Energy Research Inst., Tokyo (Japan). Jan 1989. 135p. (In Japanese). Order Number DE90701620/JAW. Available from NTIS (US Sales Only), PC A07/MF A01.

Cobalt Irradiation Facility No.1 was constructed in 1964 as the first large scale Co-60 irradiation facility equipped a deep water pool for source storage of Co-60 sources. Recently, the reconstruction of the facility was decided because the aging of various parts of the facility became remarkable and new research programs required upgradings of the facility. Important points of upgradings are as follows: A shielding capacity of the source storage and pool is increased to 55.5 PBq from 18.5 PBq. The opening in a floor of the irradiation room which is used for the source lifting in the room, is enlarged in order to utilize a large and high intensity source. Radiation resistance of the irradiation apparatus and installed equipments in the radiation room is increased for a high dose rate irradiation. Basic structure and shape of the facility building such as shielding, pool and building roof is not changed but electrical, mechanical equipments and systems are completely renewed. To increase a reliability, the irradiation apparatus and systems are also replaced with an improved and up-to-date one designed based on operation experiences of Co-60 facilities at TRCRE through many years. In addition, auxiliary equipments such as radiation monitors, manipulators, water treatment system and so on are replaced. This report presents the reconstruction of Co-60 Irradiation Facility No.1 stressing on the replacement and modification of the irradiation apparatus. (author).

47016 **Energy in physics, war and peace.** Mark, H. 410p. Kluwer Academic Publishers, Norwell, MA (1988).

The first part of this volume comprises papers dealing with basic areas of physics ranging from relativistic radiative hydrodynamics through nuclear decay selection rules to stellar X-ray sources and elemental synthesis. The second part presents contributions which address various aspects of physics applied to the creation of military strength, such as the history of nuclear explosives and the development of beam weaponry. The last part contains contributions which relate to some of the areas of physics applied to peaceful purposes in which Teller has worked.

08 HYDROGEN

0801 Production

Refer also to citation(s) 47076

47017 (DLR-FB–89-35) **Gas evolution and bubble formation on electrodes.** Dinkelacker, M. Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Koeln (Germany, F.R.); Stuttgart Univ. (Germany, F.R.). Fakultaet 13 - Verfahrenstechnik. 1989. 150p. (In German). Order Number DE90702784/JAW. Available from NTIS (US Sales Only), PC A07/MF A01.

The influence of the bubble formation on the electrode overvoltages in alkaline water electrolysis is investigated on the cathode in dependance of the current density, variated in a wide range. Fundamental phenomena of the electrolytic gas generation and bubble formation are examined in a current density range of 10^{-4} to 10^{5} mA/cm^2, similarities and differences to thermal boiling are discussed. It is shown experimentally and theoretically that gas generation and bubble formation cause not only on ohmic potential drop but also an increase in electrochemical overvoltage and the thermodynamical potential. The experimental and theoretical results show furthermore that in the range of little current densities under 1 mA/cm^2 the bubble behaviour is governed by diffusion and therefore similar to that one at thermal boiling. In extremely high current density range above 10^{5} mA/cm^2 occurs in the limit case electrode melting due to a high heat evolution, a well known phenomenon at thermal boiling. In the intermediate technical current density range the gas generation and bubble formation is governed more and more with increasing current density by electrochemical coherences. (orig.) With 105 figs., 2 tabs., 64 refs.

09 OTHER SYNTHETIC AND NATURAL FUELS

0901 Hydrocarbon Fuels

Refer also to citation(s) 46800

47018 (UCRL–100768) **Partial oxidation reactions of methane and oxygen.** Droege, M.W.; Hair, L.M.; Pitz, W.J.; Westbrook, C.K. Lawrence Livermore National Lab., CA (USA). Mar 1989. 15p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-7405-ENG-48. (CONF-890644–1: Society of Petroleum Engineers gas technology symposium: gas technology serving a competitive market, Dallas, TX (USA), 7-9 Jun 1989). Order Number DE89017546/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In considering the typical experimental conditions used for studies of methane oxidation to oxygenates or hydrocarbons in the presence of catalysts, it is clear that a significant potential exists for the appearance of non-catalyzed, thermally activated gas-phase reactions of methane and oxygen. In order to identify and describe the contribution of the gas phase processes during catalyzed reactions, a chemical kinetic model (HCT) developed at this Laboratory has been employed to describe these homogeneous gas phase reactions. Overall, the model predicts very well the trends and steady state results observed when tested against a series of experimental reactions comparing the effects of various reaction parameters such as residence time, temperature, and gas composition. The ability to

accurately predict the magnitude of these background reactions should provide a means to begin to dissect the contributions of thermal gas phase chemistry from those of solely catalytic action. New catalysts materials containing niobium and lanthanum have been synthesized. It is observed that niobium alone at high loading levels is an oxidation catalyst facilitating the production of carbon dioxide. This behavior is modified when lanthanum is incorporated into the catalyst material. In that case, improved selectivity to oxidative coupling products of methane is observed. 20 refs., 7 figs.

47019 (UCRL–100943) **Conversion of methane to liquid hydrocarbons.** Droege, M.W.; Hair, L.M. Lawrence Livermore National Lab., CA (USA). Apr 1989. 12p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-7405-ENG-48. (CONF-890492–3: Natural gas research and development, Morgantown, WV (USA), 18-19 Apr 1989). Order Number DE89017547/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The major emphasis of this project is the development of new catalyst materials which facilitate reactions that convert methane to liquid fuels. Reactions of interest include partial oxidation (forming methanol and formaldehyde) or oxidative coupling (forming ethane and ethylene) of methane using oxygen. Our efforts have focused both on describing the gas phase reactions of methane and oxygen that lead to methane oxidation and on development of new catalysts that select and accelerate the partial oxidation or coupling reactions. We have employed a chemical kinetic model (HCT: Hydrodynamics, Chemical kinetics, and Transport) that was developed at this Laboratory to describe homogeneous gas phase reactions. In addition, we have focused on the synthesis and reactions of new catalyst materials that would serve as the basis for methane conversion processes. The catalysts typically consist of an inorganic oxide matrix such as SiO_2 in which early transition metal and lanthanide ions are incorporated into the oxide coordination environment of the matrix. Characterization studies have been used to elucidate both the bulk properties of the catalysts as well as to determine details of the metal ion coordination environment. Reactor studies testing the foregoing catalysts for methane partial oxidation reactions are in progress and the results will be correlated with both the characterization data and with chemical kinetic modelling of the thermal reactions of methane and oxygen. 18 refs., 5 figs., 1 tab.

47020 (VTT-TIED–967) **Updraft gasification of waste fuels.** Staahlberg, P.; Simell, P.; Wihersaari, M.; Filen, H. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Apr 1989. 71p. (In Finnish). Order Number DE89914694/JAW. Available from NTIS (US Sales Only), PC A04/MF A01.

The aim of the research was to extend the range of use of gasification technique by studying the suitability of waste fuels for the fuel of an updraft gasifier, and gas clean-up with a method based on thermal cracking. Experiments were carried out mainly at a test plant with 1 MW nominal effect. Municipal waste, straw, forest residue and vehicle scrapyard waste were used in the experiments. The gasifier in its present assembly operates well with forest residue and vehicle scrapyard waste and satisfactorily with piece-shaped municipal waste. Crushed and chopped municipal waste and straw require either the use of mixture fuel or changes in the construction and dimentions of the gasifier. For the use of municipal waste and other waste fuels of this kind the gasifying plant must be equipped with flue gas clean-up. With the scrubber used in the experiments the solids contents of the flue gas were reduced by 70% to 50 mg/m^3_n. As the specific emissions of certain components from the gasifying plant (uncleaned flue gas) are much lower than those from grate and fluidized-bed combustion, further clean-up of flue gases can be carried out at lower cost of investment. When using municipal waste the competitiveness of the gasifying plant is good size class 5-15 MW. Thermal cracking of tar contained in updraft gas was investigated with equipment, in which the heat required for cracking is produced by burning part of gas in the cracker. At the cracking temperature of 800 deg C the tar content of the product gas was 7.5-8.0 g/m^3_n, which is of the same magnitude as in fluidized-bed gasification at the same temperature, but clearly higher than in downdraft gasification. If the aim is to produce gas that requires as little as possible after-purification, cracking must be intensified by catalysts.

47021 Autoignition chemistry of N-butane in a motored engine. Pitz, W.J.; Westbrook, C.K.; Leppard, W.R. 10p. Society of Automotive Engineers, Warrendale, PA (1988). (CONF-8810120–: Society of Automotive Engineers fuels and lubricants meeting and exposition, Portland, OR (USA), 10-13 Oct 1988).

Technical Paper 881605.

A detailed chemical kinetic mechanism was used to simulate the oxidation of n-butane/air mixtures in a motored engine. The modeling results were compared to species measurements obtained from the exhaust of a CFR engine and to measured critical compression ratios. Pressures, temperatures and residence times were considered that are in the range relevant to automotive engine knock. The compression ratio was varied from 6.6 to 15.5 to affect the recycle fraction and the maximum pressure and temperature of the fuel/air mixture. Engine speeds of 600 and 1600 rpm were examined which corresponded to different fuel/air residence times. The relative yields of intermediate species calculated by the model matched the measured yields generally to within a factor of two.

47022 Photodynamics of a nickel hydrocorphinoid model of F_{430}. Crawford, B.A. (Univ. of New Mexico, Albuquerque (USA)); Findsen, E.W.; Ondrias, M.R.; Shelnutt, J.A. *Inorganic Chemistry (USA),* 27(11): 1842-1846 (1 Jun 1988). DOE Contract AC04-76DP00789.

A nickel hydrocorphinoid derivative, F_{430}, catalyzes the final step in the complex series of reactions in the production of methane from carbon dioxide and hydrogen. In this paper, the transient Raman studies of the photodynamics of four- and six-coordinate complexes of nickel hydrocorphinoid related to F_{430} are reported. Results of previously reported studies of the transient photoligation behavior of nickel porphyrins are coupled with data from the Raman studies. Photochemical results for the nickel hydrocorphinoids were found to be quite different from that of nickel porphyrin analogues. These results led to a suggestion that nickel hydrocorphinoids may form a functionally distinct class of prosthetic groups with dynamic and electronic characteristics. 28 references, 5 figures, 1 table.

47023 Cyclopentane formation in the reduction of 1,5-dihaloalkanes with a nickel(I) macrocycle. Ram, M.S. (Iowa State Univ., Ames (USA)); Bakac, A.; Espenson, J.H. *Inorganic Chemistry (USA),* 27(11): 2011-2012 (1 Jun 1988). DOE Contract W-7405-ENG-82.

When the nickel(I) macrocycle, $Ni(tmc)^+$, reacts with 1,5-dihalopentanes, $X(CH_2)_5X$ (X = Br, I) cyclopentane is produced in nearly quantitative yield. The reaction scheme for the process is presented as follows: Ni $(tmc)^+$ reacts with $X(CH_2)_5X$ by an atom-transfer process to yield $X(CH_2)_4CH_2{}^0$; this radical reacts with a second $Ni(tmc)^+$ to yield the organometallic complex $(tmc)Ni(CH_2)_4CH_2X^+$. Cyclopentane results from the $ni(tmc)^+$-catalyzed decomposition of $(tmc)Ni(CH_2)_5X^+$. 14 references, 1 table.

0902 Alcohol Fuels

Refer also to citation(s) 46805, 46916, 47626, 47646

47024 (DOE/ER/13615–3) **Catalogic hydrogenation of carbon monoxide: Final progress report, September 15, 1988–September 14, 1989.** Wayland, B.B. Pennsylvania Univ., Philadelphia, PA (USA). Board of Trustees. Sep 1989. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER13615. Order Number DE89017813/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This project is focused on developing strategies to accomplish the hydrogenation of carbon monoxide to produce organic oxygenates at mild conditions. Our approaches are based on the recognition that rhodium macrocycles have unusually favorable thermodynamic values for producing a series of intermediates implicated in the catalytic hydrogenation of CO. Observations of metalloformyl complexes from reactions of H_2 and CO, and reductive coupling of CO to form metallo α-diketone species have suggested a multiplicity of routes to organic oxygenates that utilize these species as intermediates. Thermodynamic and kinetic-mechanistic studies are used in constructing energy profiles for a variety of potential pathways, and

these schemes are used in guiding the design of new metallospecies to improve the thermodynamic and kinetic factors for individual steps in the overall process. Variation of the electronic and steric effects associated with the ligand arrays along with the influences of the reaction medium provide the chemical tools for tuning these factors. Current studies are directed toward the use of non-macrocyclic ligand complexes that emulate the favorable thermodynamic features associated with rhodium macrocycles, but that also manifest improved reaction kinetics. Multifunctional catalyst systems designed to couple the ability of rhodium complexes to produce formyl and diketone intermediates with a second catalyst that hydrogenates these intermediates are promising candidates to accomplish CO hydrogenation at mild conditions. 7 refs.

47025 (DOE/ER/13625–3) **Model Cu/ZnO catalysts for methanol synthesis: The role of surface structure: Progress report.** Campbell, C.T. Indiana Univ., Bloomington, IN (USA). [1989]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER13625. Order Number DE89017421/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Catalysts based on CuO/ZnO mixtures are well known for their activity and selectivity in the methanol synthesis reaction ($CO + 2H_2 \rightarrow CH_3OH$). These catalysts are also widely used for water-gas shift ($CO + H_2O \leftrightharpoons CO_2 + H_2$), which occurs together with methanol synthesis under most conditions, there still remains a considerable controversy over the nature of the active sites and the relationship between surface structure and catalyst activity. Previous research on these catalysts have been in two areas: (1) kinetic studies of high-surface-area Cu/ZnO catalysts under realistic reaction conditions and their subsequent structural characterization, and (2) surface science studies on well-defined surfaces of Cu and ZnO single crystals, where adsorption and desorption processes of the reactants and products have been characterized under ultra high vacuum (uhv) conditions. The goal of our research project is to help bridge the gap between these two disparate bodies of research. We thus are attempting to correlate reaction kinetics made at medium-pressure conditions (<10 atm.) on well-defined single-crystal surfaces with: (1) kinetics at similar conditions on high surface area Cu/ZnO catalysts, (2) details of the atomic-level surface structure, and (3) information on adsorption/desorption phenomena available from uhv surface science studies.

47026 (IGCE–7609) **Economic pre-feasibility study: large-scale methanol fuel production from surplus Canadian forest biomass. Part 1, summary report.** InterGroup Consulting Economists Ltd., Winnipeg, MB (Canada); SNC Group, Montreal, PQ (Canada); Charnell (Gordon S.) and Associates, Vancouver, BC (Canada); Gardiner (S.G.) Engineering Services Ltd., Vancouver, BC (Canada). 1976. 109p. (CE–02444). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1; $0.34CAN per page, $3.40 CAN minimum.

This study investigates the practicability of fuel grade methanol production from large scale plants (50-200 MM GPY) using surplus renewable Canadian forest roundwood, and the extent to which such production could substitute for nonrenewable hydrocarbon resources (oil, gas and coal) in meeting Canadian energy requirements. The study also investigates the broader implications of moving towards eventual high reliance upon renewable fuel alcohol to meet longer term Canadian energy requirements (particularly for transport purposes) during the next fifty years. The report begins with a review of potential Canadian demand by region for fuel grade methanol, and indicates possible refinery prices. Surplus roundwood availability and the opportunity costs of using this forest biomass for methanol fuel production are examined, including transport costs between refining centres and the surplus forest regions, noting the possible net back prices which methanol plants could receive in these regions. A discussion of technologies, characteristics and costs for the gasification and methanol synthesis process, and for forest harvesting and chipping activities is given, with an overview financial analysis and appraisal of the net prices and costs expected in order to determine under what conditions and for which possible locations methanol plants could be expected to operate profitably in Canada. The report concludes with a review of associated economic impacts and their institutional implications for the range of profitable situations studied.

47027 (SERI/SP–231-3520) **Anaerobic digestion: Annual report, FY 1988.** Solar Energy Research Inst., Golden, CO (USA). Jun 1989. 163p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE89009453/JAW. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

Anaerobic digestion research is being undertaken by the Department of Energy under the field management of the Solar Energy Research Institute to produce methane from biomass and waste. Primary focus is on municipal solid waste (MSW) as a feedstock but some efforts are ongoing using other biomass feedstocks. MSW represents a vast resource for energy production; however, its variability presents unique problems in using it as a feedstock. To make methane production from waste and biomass economical, researchers are addressing three major technological improvements: (1) increasing solids loading, (2) decreasing solids residence time, and (3) improving conversion efficiency. Improvements have been made in all three areas through biological and engineering research activities and have resulted in a decrease in methane production cost from approximately $8.00/million Btu in 1980 to less than $5.00/million Btu today. Future research will continue to increase our understanding of the organisms involved in the anaerobic digestion process and their interactions. Both biological and engineering research will continue in order to decrease the cost in methane to less than $3.50/million Btu by the year 2000.

47028 **The Department of Energy's Federal Methanol Fleet.** McGill, R.N.; Hillis, S.L. 10p. Society of Automotive Engineers, Warrendale, PA (1988). (CONF-8810120–: Society of Automotive Engineers fuels and lubricants meeting and exposition, Portland, OR (USA), 10-13 Oct 1988).

Technical Paper 881629.

The Federal Methanol Fleet Project, a demonstration authorized by the U.S. Congress in fiscal year 1985 and managed by the Oak Ridge National Laboratory (ORNL) for the Department of Energy, has operated methanol-fueled vehicles for nearly three years with a total of 20 methanol vehicles and 19 comparable gasoline vehicles now operating at three different sites. This paper summarizes the results and comparisons of the various fleet operations thus far. The methanol fleet at Argonne National Laboratory has been specially equipped for cold-weather operation, and performance of the methanol vehicles in those circumstances has been very adequate.

0904 Solid Waste and Wood Fuels

Refer also to citation(s) 46902, 47020, 47034

47029 (PB–89-191415/XAB) **Continuum-mechanical derivation of the conservation equations for the pyrolysis and combustion of wood. Research report.** Wichman, I.S. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). 1989. 50p. (VTT/RR–591). Available from NTIS, PC EE03/MF A01.

The equations for conservation of mass, species and energy for both the gas and solid phases are averaged over a characteristic wood-volume element during pyrolysis or combustion. The presence of a pure liquid phase in wood is neglected in the study. The wood sample is assumed to obey the continuum hypothesis once phase averaging is completed. Heat conduction, adsorption (and desorption) and chemical reaction-occur at the interface between gas and solid. Overall conservation equations are written for mass and energy; the species equations for the two phases are kept separate. Integration of the momentum equation for the gas phase produces an expression for the velocity field in the sample. Simplified equations are written for two limiting cases of significant practical interest.

14 SOLAR ENERGY

1405 Solar Energy Conversion

Refer also to citation(s) 47026, 47027, 47287, 47449, 47454, 47456, 47540, 48030

47030 (CONF-8905199–2) **Biomass energy for Mississippi.** Wright, L.L.; Draper, H.; Badger, P.C.; Brooks, R.T. Jr.; Straka, T.J.; Walter, D.K.; Stevens, D.; Hanna, F.; Lee, S. Oak Ridge National Lab., TN (USA). [1989]. 7p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From State of Mississippi energy future symposium; Jackson, MS (USA); 21-24 May 1989. Order Number DE89016288/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Biomass is organic matter that is available on a renewable basis. Examples include wood, crop wastes, and municipal wastes. Biomass is a significant but largely unrecognized contributor to the energy resources in the state of Mississippi. It may be surprising to many Mississippians that 7% of the energy currently consumed in the state comes from biomass. Since that is twice the contribution of biomass energy on a national level, Mississippi is already a leader in the use of biomass energy. The contribution of this in-state energy source can be significantly increased and in the process provide economic development and further improvement to the quality of life of the citizens of Mississippi. Mississippi should maintain a diversity of energy options, but it is our belief that the state and its residents could collectively and individually benefit from the increased use of the biomass energy resources available within the state. Biomass feedstocks are abundant, and a variety of technologies for utilizing the resource are available. As Mississippi develops its energy plan for the 21st century the following advantages of biomass need to be considered.

47031 (ETSU-B–1156) **Evaluation of the methodology for managing existing broadleaved and coniferous woodlands for timber and energy production.** Crockford, K.J.; Corbyn, I.N.; Savill, P.S. UKAEA Harwell Lab. (UK). Energy Technology Div. 1987. 223p. Available from British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

The objective of this study was to investigate the management in the United Kingdom of existing woodlands, both broadleaved and coniferous, for the optimised production of fuelwood and timber. Existing woodlands were defined as broadleaved high forest, scrub, coppice and coppice-with-standards and coniferous plantations. This study was not concerned with very short rotation crops grown specifically for energy production. Management was assessed by considering the Land Expectation Values (i.e. Net Present Values in perpetuity) and the improvements to profitability that fuel wood can make. Areas of the study include: forest resources in Britain; the composition of existing broadleaved woodlands; the branchwood component of woodlands; volume content and yields of coppice; harvesting and marketing of fuelwood; economics of woodlands managed for fuel and timber production; woodland management and profitability. A computer program for woodland profitability analysis has been compiled and recommendations for further research and demonstration are made. (author).

47032 (N–89-20549) **Characterization of production GaAs solar cells for space.** Anspaugh, B.E. Jet Propulsion Lab., Pasadena, CA (USA). Dec 1988. 37p. (NASA-CR–184863;JPL-PUBL–88-39;NAS–1.26:184863). Available from NTIS, PC A03/MF A01.

The electrical performance of GaAs solar cells was characterized as a function of irradiation with protons and electrons with the underlying goal of producing solar cells suitable for use in space. Proton energies used varied between 50 keV and 10 MeV, and damage coefficients were derived for liquid phase epitaxy GaAs solar cells. Electron energies varied between 0.7 and 2.4 MeV. Cells from recent production runs were characterized as a function of electron and proton irradiation. These same cells were also characterized as a function of solar intensity and operating temperature, both before and after the electron irradiations. The long term stability of GaAs cells during photon exposure was examined. Some cells were found to degrade with photon exposure and some did not. Calibration standards were made for GaAs/Ge solar cells by flight on a high altitude balloon.

47033 (N–89-21100) **Evaluation of atomic oxygen resistant protective coatings for fiberglass-epoxy composites in LED.** Rutledge, S.K.; Paulsen, P.E.; Brady, J.A. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. 1989. 13p. (NASA-TM–101955;E–4649;NAS–1.15:101955;CONF-890552–: 34. international symposium and exhibition of the Society for the Advancement of Material and Process Engineering (SAMPE), Reno, NV (USA), 8-11 May 1989). Available from NTIS, PC A03/MF A01.

Fiberglass-epoxy composite masts are the prime structural members for the Space Station Freedom solar array. At the altitude where Space Station Freedom will operate, atomic oxygen atoms are the most predominant species. Atomic oxygen is highly reactive and has been shown to oxidize organic and some metallic materials. Tests with random and directed atomic oxygen exposure have shown that the epoxy is removed from the composite exposing brittle glass fibers which could be easily removed from the surface where they could contaminate Space Station Freedom Systems. Protection or fiber containment systems; inorganic based paints, aluminum braid, and a metal coating; were evaluated for resistance to atomic oxygen, vacuum ultraviolet radiation, thermal cycling, and mechanical flexing. All appeared to protect well against atomic oxygen and provide fiber containment except for the single aluminum braid covering. UV radiation resistance was acceptable and in general, thermal cycling and flexure had little to no effect on the mass loss rate for most coatings.

47034 (NBNRE–8810, pp. 14) **Research and development in wood energy harvesting and handling.** Stuart, W.B. (Virginia Polytechnic Inst.). New Brunswick Dept. of Natural Resources and Energy, Fredericton, NB (Canada). Minerals and Energy Div. 1988. (CONF-8810421–: Wood energy symposium, Fredericton (Canada), 25-26 Oct 1988; MICROLOG–89-02885). In *Wood energy symposium. Proceedings.* Available from New Brunswick Legislative Library, Government Documents Section, 766 King Street, Fredericton, NB, CAN E3B 5H1; $N/C; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1; $10 CAN.

The paper discusses research and development activities in wood energy as a function of material types: standing material, logging residues, and manufacturing residues (wet or dry). Work is still going ahead on woody fuels on a much more controlled and deliberate basis than the past. For those engaged in this area of research, there are 4 destabilizing forces to be investigated followed: fuel prices, and theirits implications for the continued usage of high-sulfur-content coal, the disposal of wood wastes, and the developing alternate markets for biomass.

47035 (ORNL/FTR–3211) **[Collection of data on tropical forest inventories, Rome, Italy, March 20–25, 1989]: Foreign trip report.** Brown, S.; Gillespie, A. Oak Ridge National Lab., TN (USA). 6 Apr 1989. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017390/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

All forestry information in the library of FAO was organized into country "boxes," and all boxes for countries in tropical Asia and tropical America were searched for data on forest inventories. Information on location and extent of inventories and resulting stand and stock tables were obtained for (1) converting to biomass by using methods that were already developed and (2) calculating expansion factors (commercial volume to total biomass). This work was conducted by the University of Illinois (Drs. Sandra Brown, Principal Investigator, and Andrew Gillespie, Research Associate) for the Department of Energy's Energy Systems Program managed by Oak Ridge National Laboratory. The travelers were successful in obtaining copies of some data for most countries in tropical Asia and tropical America. Most of the inventories for Asia were for only parts of countries, whereas most in America were national in scale. With the information gathered, the travelers will be able to make biomass estimates, geographically referenced, for many forest types representing thousands of hectares in most countries in these two tropical regions.

47036 (ORNL/FTR–3297) **[Energy projects in the Dominican Republic]: Foreign trip report, May 14–26, 1989.** Waddle, D.B. Oak Ridge National Lab., TN (USA). 21 Jun 1989. 5p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE89017468/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

On May 14, the traveler left for Santo Domingo to gather data and negotiate the terms of a project agreement with the Asociacion de la Desarrollo de la Provincia Duarte in San Francisco de Macoris, Dominican Republic. Interviews with Asociacion management, local vendors and others involved in dissemination of small energy systems in the rural areas in the Dominican Republic, were held over a one week period. The terms of the project were discussed at length, concerns noted and an agreement was reached on a number of key items. A strategy and schedule were determined. The traveler left Santo Domingo on May 19, 1989 and arrived in Oak Ridge the following day.

47037 (ORNL/FTR–3352) **[Function of active-site residues of ribulosebisphosphate carboxylase/oxygenase, Stockholm, Sweden, and visit to Uppsala, Sweden, August 6–12, 1989]: Foreign trip report.** Hartman, F.C. Oak Ridge National Lab., TN (USA). 22 Aug 1989. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017334/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler participated in the 8th International Congress on Photosynthesis by presenting a paper entitled "Function of Active-Site Residues of Ribulosebisphosphate Carboxylase/Oxygenase" and by chairing a discussion session on the same enzyme. Presentation concerning biological CO_2 fixation, chemical modifications of proteins, 3D structure of proteins, and site-directed mutagenesis were relevant to ongoing investigations of the Protein Engineering Program at ORNL's Biology Division.

47038 (OY/PSTL-TIED–64) **Composting of surface peat, waste water sludge and bark, the properties and suitability of substietes for growing media for landscaping.** Eijaervi, E.; Holappa, K. Oulu Univ. (Finland). Research Inst. of Northern Finland. 1989. 44p. (In Finnish). Order Number DE89914696/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

Composting experiments were carried out using peat, water purification sludge and bark chips with the aim of developing soil mixtures suitable for use in public gardens and landscaping. Various proportions of the above components were tested in order to optimize composting. The process was monitored by measuring temperature at depths of 25 cm, 50 cm and 150 cm at 4-8 day intervals and electrical conductivity, acidity and organic matter content from time to time. The resulting composts were used to produce substrates for plant cultivation with 10, 25, 50 and 75% additions of sand. A corresponding commercial product and a sample of pure Carex peat were also tested in the same way. The physical and chemical properties of the substrates were determined in the laboratory, chemical compositions being defined for the initial materials and the resulting composts. The physical properties examined were water content, bulk density, condition density, acidity, electrical conductivity, organic matter (humus) content, humus as a function of particle size, cation exchange capacity, total porosity, water, air and solid vollumes, degree of saturation, water binding capacity, water capacity, air capacity, water permeability and grain size distribution curves. The mixtures were tested as substrates for the germination and cultivation of garden pansies (var. Abendglut) and in terms of their drying and rewatering properties.

47039 (OY/PSTL-TIED–65) **Use of surface peat in growing media for landscaping and public gardens in Northern Finland.** Holappa, K. Oulu Univ. (Finland). Research Inst. of Northern Finland. 1989. 92p. (In Finnish). Order Number DE89914697/JAW. Available from NTIS (US Sales Only), PC A05/MF A01.

When preparing mires for peat mining it is necessary to remove the poorly humified surface which is unsuitable for fuel purposes. On the other hand, a survey of problems and development requirements regarding landscaping and the creation of pulic parks and gradens in Northern Finland in 1985 pointed to a shortage of suitable soils for use at such sites. On the basis of preliminary investigations, research was therefore initiated with the aim of developing means of utilizing surface peat for such purposes. Lawn cultivation experiments employing additional soil layers of different compositions and thicknesses were commenced the following year at the Ruukki and Apukka experimental stations of the Finnish Agricultural Research Centre. The soil mixtures used were subsoil improved with peat, a mixture of peat and sand, peat and limestone water purification sludge, peat and aluminium sulphate water purification sludge, bark chips and water purification sludge, and peat alone. Composting experiments were carried ou using five mixtures of peat, bark chips and sludge, and the resulting composts were mixed with mineral soil and used as substrates for the cultivation of Rosa rugosa and Pinus sylvestris. Blends of the various composts with sand were also tested as substrates for garden pansies (var. ^Abendglut). Opinions were sought from peat users on the practical advantages and problems associated with its use and at the same time a survey was made of their practical quality requirements with respect to peat products. A new peat classification was constructed from the data acquired on the structure of peat, its properties and its possible practical applications. Finally, a set of instructions for the use of surface peat for soil improvement purposes were drawn up on the basis of the experimental and survey data.

47040 (SAND–89-2009C) **Photovoltaic system research status.** Post, H.N.; Jones, G.J.; Thomas, M.G. Sandia National Labs., Albuquerque, NM (USA). 1989. 6p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. (CONF-890923–1: World congress of the International Solar Energy Society, Kobe (Japan), 4-8 Sep 1989). Order Number DE89016764/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

After a decade of photovoltaic system research, most system related issues have been successfully resolved. Current system research activities are now oriented toward maintaining and updating the comprehensive database on system performance established by previous research efforts, integrating new components into system designs, and transferring the accumulated information to industry and users of the technology. This paper presents a brief overview of the status of system research in the United States, emphasizing three key activities - field evaluation, balance-of-system hardware development, and technology transfer. 5 refs., 2 tabs.

47041 (SERI/STR–211-3562) **Preparation and properties of high deposition a-Si:H films and solar cells using disilane: Final subcontract report, 1 May 1988–30 April 1989.** Chatham, H.; Bhat, P.K. Glasstech Solar, Inc., Wheatridge, CO (USA). Sep 1989. 27p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-83CH10093. Order Number DE89009467/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The focus of research during the second phase of SERI Contract No. ZB-7-06002-1 was the fabrication of high efficiency amorphous silicon p-i-n solar cells using intrinsic layers deposited at high deposition rate (−2 nm/s) from disilane discharges. In order to achieve this goal, we utilized higher discharge excitation frequencies (10-110 MRz) to improve the intrinsic layer properties. In this report, we discuss the influence of the driving frequency at fixed fr power density on silane and disilane discharges, the properties of materials deposited from these discharges, and the performance of p-i-n devices fabricated using intrinsic layers deposited at a rate of −2 nm/s from disilane 110 MRz discharges. The use of higher excitation frequency in disilane discharges increases the deposition rate and results in films with improved properties compared with those deposited at similar deposition rate by increasing the rf power. As a result of these improvements, we have fabricated a p-i-n device at a deposition rate of 2nm/s with an AM1.5 efficiency of 9/7% over an area of 1 cm^2. This result exceeds the goals of this contract. 24 refs., 16 figs., 2 tabs.

1406 Photovoltaic Power Systems

47042 (AFME-Z–0089) **Photovoltaic power supply in 40 remote houses in France.** Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). Oct 1987. 100p. (In French). Order Number DE89764082/JAW. Available from NTIS (US Sales Only), PC A05/MF A01.

A photovoltaic program for the electrification of 40 remote houses in the south of France is presented. The 40 equipments are standardized through various power levels (400 W, 800, ..., AC1500W). The program has been evaluated through its technical aspects (reliability, standardization, ease of operation), economical aspects (comparison with other solutions: generating sets, connexion to the

network,...), sociological aspects (comfort, satisfaction), and administrative aspects (new procedures between the users and the concerned establishments).

47043 (N–89-19493) **Starting characteristics of direct current motors powered by solar cells.** Singer, S.; Appelbaum, J. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Mar 1989. 20p. (NASA-TM–101981;E–4550-1;NAS–1.15:101981). Available from NTIS, PC A03/MF A01.

Direct current motors are used in photovoltaic systems. Important characteristics of electric motors are the starting to rated current and torque ratios. These ratios are dictated by the size of the solar cell array and are different for the various dc motor types. Discussed here is the calculation of the starting to rated current ratio and starting to rated torque ratio of the permanent magnet, and series and shunt excited motors when powered by solar cells for two cases: with and without a maximum-power-point-tracker (MPPT) included in the system. Comparing these two cases, one gets a torque magnification of about 3 for the permanent magnet motor and about 7 for other motor types. The calculation of the torques may assist the PV system designer to determine whether or not to include an MPPT in the system.

47044 (N–89-21174) **Restrictive loads powered by separate or by common electrical sources.** Appelbaum, J. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Mar 1989. 20p. (NASA-TM–102008;E–4594;NAS–1.15:102008). Available from NTIS, PC A03/MF A01.

In designing a multiple load electrical system, the designer may wish to compare the performance of two setups: a common electrical source powering all loads, or separate electrical sources powering individual loads. Three types of electrical sources: an ideal voltage source, an ideal current source, and solar cell source powering resistive loads were analyzed for their performances in separate and common source systems. A mathematical proof is given, for each case, indicating the merit of the separate or common source system. The main conclusions are: (1) identical resistive loads powered by ideal voltage sources perform the same in both system setups, (2) nonidentical resistive loads powered by ideal voltage sources perform the same in both system setups, (3) nonidentical resistive loads powered by ideal current sources have higher performance in separate source systems, and (4) nonidentical resistive loads powered by solar cells have higher performance in a common source system for a wide range of load resistances.

1407 Solar Thermal Power Systems

47045 Design of direct-contact preheater/boilers for solar pond power plants. Wright, J.D. (Solar Energy Research Institute, Golden, CO (US)). vp of Direct-contact heat transfer. Kreith, F.; Boehm, R.F. Hemisphere Publishing, New York, NY (1988).

Salt-gradient solar ponds may provide the simplest and least expensive method of converting solar to thermal energy. The pond combines the functions of both collection and storage. Because the salt gradient suppresses thermally induced convection, temperatures of 75^0 - 100^0C may be achieved in the storage layer. Thermal energy from ponds may be used to generate electricity, because the low collection cost offsets the inherently poor efficiency of the low-temperature power cycle. One promising method of power production is the organic Rankine cycle. Because of the low efficiency of the conversion cycle, the shell-and-tube heat exchangers for heat addition and rejection are the major capital expense. Replacing these heat exchangers with direct-contact heat exchangers can result in major cost reductions. This report critically reviews the methods available for sizing direct-contact heat exchangers used to couple an organic (pentane) Rankine cycle to a solar pond.

1409 Solar Thermal Utilization

Refer also to citation(s) 47265

47046 (AD-A–207555/4/XAB) **High-temperature solar electrothermal processing. Final report, July 1982-March 1989.** Fletcher, E.A. Minnesota Univ., Minneapolis, MN (USA). Dept. of Mechanical Engineering. 18 Apr 1989. 8p. Available from NTIS, PC A02/MF A01.

Chemical transformation at a given temperature and pressure requires a total energy that, Delta H of the chemical reaction. The minimum amount of energy which must be supplied as (electrical) work is Delta G of the reaction. The rest may be supplied as process heat or as work. Since Delta H of most chemical reactions is relatively independent of temperature, and Delta G decreases with temperature, there is an energy advantage in conducting electrolytic separations at high temperatures. At sufficiently high temperatures, all of the necessary energy may be solar process heat, replacing all of the electrical energy input, as the author experimentally observed. He conducted analytical and experimental studies a high-temperature electrolysis in a highly concentrating solar furnace as well as in an electric furnace. He sought and found suitable materials for construction of electrodes and cells and appropriate reactions that will acquire technological significance, designed and built receivers for sunlight and reactors that can interface with them, acquired operating experience with them, and conducted electrochemical and thermochemical measurements.

47047 (DOE/SF/15754–T1) **Investigation of needs for active solar design tools: [Final report], October 1, 1985–February 1, 1986.** American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, GA (USA). Feb 1986. 87p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG03-85SF15754. Order Number DE89015608/JAW. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This report is an investigation into the perceived strengths and weaknesses of current active solar heating design information and tools; and an investigation as to which solar research results should be cited in new active solar heating design instruments.

1410 Solar Collectors and Concentrators

Refer also to citation(s) 47045, 47046

47048 (AFME–85.91.1003.2) **Design and construction of thermal solar equipments: flat plate solar collectors.** Chevalier, J.L. Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France); Centre Scientifique et Technique du Batiment, 75 - Paris (France). Dec 1986. 109p. (In French). Order Number DE89764083/JAW. Available from NTIS (US Sales Only), PC A06/MF A01.

After a presentation of the various types and applications of flat plate solar collectors and their different elements, the data concerning operation conditions, durability and thermal performances of the collectors are described. Each element is then developed to provide criteria of choice for the design and construction, considering mainly the material properties: corrosion resistance, optical properties, ageing, heat transfer fluids, etc.

47049 (NEI-DK–200, pp. 51-66) **Attractive economy and durability of building integrated solar collector systems.** Vejsig Pedersen, P. (Thermal Insulation Laboratory, Lyngby (DK)). Danmarks Tekniske Hoejskole, Lyngby (Denmark). Lab. for Varmeisolering. May 1986. In *Avoidance of failures in solar collector systems. IEA Task 3: performance testing of solar collectors, Subtask F: service life testing of solar collector components and materials.* Order Number DE89914673/JAW. Available from NTIS (US Sales Only), PC A05/MF A01.

An advantage of building integrated solar collector systems is that often the solar components also function as a building envelope. Two demonstration projects with large roof integrated, site-built solar collectors for DHW built near Copenhagen are described. One solar collector has 208 m^2 of collector area integrated in an existing building and forming part of a roof renovation. The other solar collector has a collector area of 160 m^2 and was used in a new building project. The solar collector was developed with a special acrylic glazing which is easy to install. It is completely rain tight and well ventilated. In a building project north of Copenhagen, where 40 out of 55 solar low energy houses were equipped with a new type of compact thermosyphon solar water heater, originally developed at the Thermal Insulation Laboratory is described. Integrated in the wall in the living room, a selective absorber and 16 cm thick, 150

liter DHW tank with an electric heater as back-up, were installed behind an ordinary 3.5 m^2 window with a tilt of 57 deg. 3 monitored systems show that a yearly system efficiency of 50% is possible for a daily DHW demand of 200 liter being equal to a solar fraction of 65% or a coefficient of performance of 3.0 Economic aspects are also dealt with. At the Thermal Insulation Laboratory, several passive solar heating research projects have also been carried out. However, to obtain better possibilities for control, which can be necessary in an unstable climate like the Danish, various hybrid heating systems have been investigated. An example is the so-called loft room solar collector. This system is an ordinary, black painted loft room with a transparent roofing. A rock-bed storage is charged by air heated in the loft room. This is an inexpensive solar system with a quite high solar fraction. The importance of using solar technology in new building projects is discussed. 11 refs.

1420 Heat Storage

47050 (PIRSEM–1070.1) **Modelization and identification of a latent heat buffer storage for its real time control.** Maye, J.P.; Legrand, S. Centre National de la Recherche Scientifique, 75 - Paris (France). Programme Interdisciplinaire de Recherche sur les Sciences pour l'Energie et les Matiernes Premieres (PRISEM); Poitiers Univ., 86 (France). Nov 1986. 55p. (In French). Order Number DE89764078/JAW. Available from NTIS (US Sales Only), PC A04/MF A01.

An experimental high temperature latent heat storage system composed of many storage tube containing the phase change material is described. A model is developed, which gives in real time, the heat transfer fluid temperature and the phase change material temperature. Each tube operation is modelized. The heat storage system, operating as a buffer in drying or vapor processes, is then modeiized and optimized in order to achieve a constant temperature heat production process.

15 GEOTHERMAL ENERGY

47051 (CONF-890352–) **DOE research and development for the geothermal marketplace: Geothermal program review 7: Proceedings.** USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (USA). Geothermal Technology Div.; Meridian Corp., Alexandria, VA (USA). [1989]. 196p. Sponsored by U.S. DOE Conservation & Renewable Energy. From US Department of Energy research and development for the geothermal marketplace: 7th geothermal program review; San Francisco, CA (USA); 21-23 Mar 1989. Order Number DE89015627/JAW. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

Each year the Geothermal Technology Division of the US Department of Energy conducts an indepth review of its entire geothermal R and D program. The 2–3 day conference serves several purposes: a status report on current R and D activities, an assessment of progress and problems, a review of management issues, and a technology transfer opportunity between DOE and the US geothermal industry. This year's conference, Program Review 7, was held in San Francisco on March 21–23, 1989. As indicated by its title, "DOE Research and Development for the Geothermal Marketplace", Program Review 7 emphasized developing technologies, concepts, and innovations having potential for commercial application in the foreseeable future. Program Review 7 was comprised of eight sessions including an opening session and a special presentation on the "Role of Geothermal Energy in Minimizing Global Environmental Problems." The five technical sessions covered GTD-sponsored R and D in the areas of hydrothermal (two sessions), hot dry rock, geopressured, and magma. Presentations were made by the relevant field researchers, and sessions were chaired by the appropriate DOE Operations Office Geothermal Program Manager. The technical papers and commentary of invited speakers contained in these Proceedings have been compiled in the order in which they were presented at Program Review 7.

1502 Geology and Hydrology of Geothermal Systems

47052 (ETSU-G–145) **Preliminary assessment of offshore platform conversion to geothermal power station.** Turner, M.J. UKAEA Harwell Lab. (UK). Energy Technology Div. 1989. 78p. Available from British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

A preliminary review of the technical, legal and economic issues associated with the conversion of redundant offshore platforms to geothermal power stations has been undertaken. The study sought to use existing geothermal power generation technology and other existing technology and confined itself to the use of abandoned but pre-existing reservoirs. Whilst there appears to be no large technical problem, existing reservoir temperatures are not high enough to give acceptable rates of return at any realistic combination of assumptions. Future studies should concentrate therefore on: (i) the technical complexity and economic benefits of extending reservoir depth which will involve deep geology concepts and will need to be more site specific than the present study; and (ii) the use of a heat exchanger system that will give good net energy balances from fluid temperatures in the range 80^{0}C -120^{0}C. An efficient economic model exists to test the impact and robustness of technical advance on concept economics. Legislation would be necessary to permit and regulate this change of use but would be confined to national legislation, international law already permitting the activity. The concept is environmentally friendly. (author).

1503 Geothermal Exploration and Exploration Technology

47053 (ETSU-G–137-P14A) **Camborne geothermal energy project 2C-7 resource evaluation. V. 1. Overview.** Willis-Richards, J.; Jones, R.H.; Baria, R. UKAEA Harwell Lab. (UK). Energy Technology Div. 1989. 71p. Available from British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

A three dimensional model of the shape of the Cornubian granite batholith is derived from gravity, density and wide angle seismic surveys. A normal incidence seismic reflection survey was shot to investigate the internal structure of the batholith and its shape. Surface heat flow, heat generation by natural radioactive decay and thermal conductivity data are combined with this model of the granite to predict upper crustal temperatures in South West England. The thermal model is then used to evaluate the Hot Dry Rock (HDR) accessible resource base and its variation with drilling and temperature criteria. Sensitivity of temperature estimation, at a hypothetical HDR site, to certain of the modelling assumptions is examined. The natural seismicity of Cornwall is reviewed and used to support theoretical arguments concerning the in situ stresses likely to be found in HDR reservoirs at temperatures in excess of 200^{0}C. The effect of the thermo-rheological properties of granite on geological structures at depth is discussed. (author).

47054 (ETSU-G–137-P14B) **Camborne geothermal energy project 2C-7 resource evaluation. V. 2. Seismic reflection survey.** Jones, R.H. UKAEA Harwell Lab. (UK). Energy Technology Div. 1989. 63p. Available from British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

Two seismic reflection lines with a total length of 71.5 km were shot over the Carnmenellis Granite. The survey was designed (1) to investigate the structure of the granite between 4 and 8 km and, (2) to delineate the size and shape of the granite. The data were processed and seismic sections of the two lines produced. Most of the processing was standard although some non-standard techniques were used. The seismic sections show many short reflectors within the Killas where it attains a thickness of more than 0.5 km. These continue down to about 4.5 km in the killas or stop at the killas/granite boundary if it is shallower than this. There are no reflectors within the granite. One short, weak reflector is imaged below the granite, at a depth of 16 km, on one of the lines. (author).

47055 (ETSU-G–137-P14C) **Camborne geothermal energy project 2C-7 resource evaluation. V. 3. Gravity and thermal modelling.** Willis-Richards, J.; Baria, R. UKAEA Harwell Lab. (UK). Energy Technology Div. 1989. 97p. Available from British Library

Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

Heat flow, heat productivity and thermal conductivity data are combined with a three dimensional model of the space form of the Cornubian batholith derived from Bouguer gravity anomalies to enable a three dimensional thermal model to be calculated. This model is used to estimate the size of the thermal resource in South West England. The shape of the batholith determined by modelling the gravity anomaly pattern which is caused by a density contrast between the granite and the surrounding country rocks shows that it averages 12 to 15 km thickness with a marked shallowing of the base to the north. Between the exposed cupolas the granite is little more than 2 km from the surface. The mapped distribution of contact metamorphic effects is consistent with the model. The current preferred thermal model indicates that large areas of granite with temperatures in excess of 220^{0}C at 6 km depth are present, and that in the most favourable parts the temperature may exceed 240^{0}C at this depth. The minimum thermal resource available is about 1-1.5 x 10^{21} Joules. Very approximately 0.4% of this thermal resource may potentially be delivered as useful electric power. On this basis the 'electrical resource' is between 1100 and 1700 Twh. This compares with 200 Twh probable and 2000 Twh possible resources identified previously. The chief uncertainties in the resource assessment no longer relate to the existence of granite at suitable temperatures, but in the efficiency with which heat can be extracted from it. (author).

1506 Environmental Aspects and Waste Disposal

Refer also to citation(s) 47056

1508 Geothermal Power Plants

Refer also to citation(s) 47056

1509 Geothermal Engineering

47056 (LA–11514-MS) **Hot Dry Rock geothermal energy— A new energy agenda for the twenty-first century.** Tester, J.W.; Brown, D.W.; Potter, R.M. Los Alamos National Lab., NM (USA). Jul 1989. 30p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-7405-ENG-36. Order Number DE89016687/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Hot Dry Rock (HDR) geothermal energy, which utilizes the natural heat contained in the earth's crust, can provide a widely available source of nonpolluting energy. It can help mitigate the continued warming of the earth through the "greenhouse effect," and the accelerating destruction of forests and crops by acid rain, two of the major environmental consequences of our ever-increasing use of fossil fuels for heating and power generation. In addition, HDR, as a readily available source of indigenous energy, can reduce our nation's dependence on imported oil, enhancing national security and reducing our trade deficit. The earth's heat represents an almost unlimited source of energy that can begin to be exploited within the next decade through the HDR heat-mining concept being actively developed in the United States and in several other countries. On a national scale, we can begin to develop this new energy source, using it directly for geothermal power or indirectly in hybrid geothermal/fossil-fueled systems, in diverse applications such as: baseload power generation, direct heat use, feedwater heating in conventional power plants, and pumped storage/load leveling power generation. This report describes the nature of the HDR resource and the technology required to implement the heat-mining concept in several applications. An assessment of the requirements for establishing HDR feasibility is presented in the context of providing a commercially competitive energy source. 37 refs., 6 figs.

1510 Direct Energy Utilization

47057 (DOE/ID/12693–3) **A materials and equipment review of selected US geothermal district heating systems.** Rafferty, K.D. Oregon Inst. of Tech., Klamath Falls, OR (USA). Jul 1989. 383p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG07-87ID12693. Order Number DE89017552/JAW. Available from NTIS, PC A17/MF A01 - OSTI; GPO Dep.

This collection of information was assembled for the benefit of future geothermal system designers and existing system operators. It is intended to provide insight into the experience gained from the operation of 13 major geothermal systems over the past several years. Each chapter contains six or seven sections depending upon the type of system: introduction, production facilities, distribution, customer connections, metering and disposal. Some chapters, covering systems which incorporate a closed distribution design include a section on the central mechanical room. Each section details the original equipment and materials installed in that portion of the system. Following each section is a discussion of the subsequent problems, solutions and modifications relating to the equipment. The extent to which information was available varied from system to system. This is reflected in the length and level of detail of the chapters.

1520 Geothermal Data and Theory

47058 (CONF-8609134–, pp. 34-40) **Development and application of stable isotope mass transfer reaction path models.** Bowers, T.S. (Massachusetts Institute of Technology, Cambridge (USA)). Lawrence Livermore National Lab., CA (USA). 1986. From Workshop on geochemical modeling; Fallen Leaf Lake, CA (USA); 14-17 Sep 1986. In *Proceedings of the workshop on geochemical modeling.* Order Number DE89008807/JAW. Available from NTIS, PC A09/MF A01.

Modifications to EQ3/6 for the inclusion of oxygen, hydrogen and sulfur isotopes allow simultaneous calculation of the chemical and stable isotopic consequences of mass transfer in geologic systems. Addition of isotopes to the computer programs provides further constraints that can be used to evaluate water-rock interaction models. An application to mid-ocean ridge hydrothermal systems is included where chemical and isotopic changes attending seawater-basalt interaction are calculated for an evolutionary path of seawater to hydrothermal endmember such as that exiting from mid-ocean ridge hot springs.

47059 (CONF-8609134–, pp. 51-57) **Preliminary chemical modeling of epithermal processes at Creede, Colorado: The role of fluid mixing as an ore deposition mechanism.** Plumlee, G.S. (Geological Survey, Denver, CO (USA)); Hayba, D.O. Lawrence Livermore National Lab., CA (USA). 1986. From Workshop on geochemical modeling; Fallen Leaf Lake, CA (USA); 14-17 Sep 1986. In *Proceedings of the workshop on geochemical modeling.* Order Number DE89008807/JAW. Available from NTIS, PC A09/MF A01.

Continuing studies of epithermal ores from the Creede district, Colorado, have provided an extensive geological and geochemical basis for guiding quantitative chemical modeling of ore deposition processes in the Creede hydrothermal system. Preliminary modeling efforts to date suggest that the mixing of hot, metal-bearing brines with cooler, dilute, oxidizing groundwaters could have produced observed district-wide mineral zoning patterns. Initial boiling of the brines in the deeper parts of the Creede vein systems prior to mixing could also have contributed to the zoning patterns, however.

47060 (CONF-8609134–, pp. 58-65) **Boiling of geothermal waters: precipitation of base and precious metals, speciation of arsenic and antimony, and the role of gas phase metal transport.** Spycher, N.F. (Univ. of Oregon, Eugene (USA)); Reed, M.H. Lawrence Livermore National Lab., CA (USA). 1986. From Workshop on geochemical modeling; Fallen Leaf Lake, CA (USA); 14-17 Sep 1986. In *Proceedings of the workshop on geochemical modeling.* Order Number DE89008807/JAW. Available from NTIS, PC A09/MF A01.

Multicomponent heterogeneous equilibrium calculations are used to model the boiling of a Broadlands-type water, mixing of the boiled water with an acid sulfate water and condensation of the gas phase separated from the boiled water. Minerals, gases and aqueous species containing arsenic, antimony and mercury are included in the calculations. Upon boiling, silicate and sulfide minerals precipitative due to temperature drop and pH increase, respectively, and mercury partitions into the gas phase. Gas transport of arsenic

and antimony is insignificant. Boiling of a sulfide-deficient water leads to native gold and silver deposition, at temperatures depending on the extent of sulfide deficiency of the solution. Mixing with acid sulfate water results in gold and enargite precipitation, together with stibnite and orpiment if the temperature is below 100 C. Condensation of the gas phase results in precipitation of cinnabar from reaction between Hg gas and H_2S gas.

47061 (CONF-8609134–, pp. 66-71) **Progressive mineral alteration and coupled ^{18}O depletions in the Lake City hydrothermal system (23 Ma), Colorado.** Larson, P.B. (Washington State Univ., Pullman (USA)). Lawrence Livermore National Lab., CA (USA). 1986. From Workshop on geochemical modeling; Fallen Leaf Lake, CA (USA); 14-17 Sep 1986. In *Proceedings of the workshop on geochemical modeling.* Order Number DE89008807/JAW. Available from NTIS, PC A09/MF A01.

Water/rock interaction in hydrothermal systems typically results in the development of alteration product phases and mass transfer of oxygen isotopes among minerals and aqueous solutions. The hydrothermal system that was established in the Lake City caldera, San Juan Mountains, Colorado, shortly after collapse about 23 Ma is well-documented, and the quantity of mineral alteration products in the hydrothermally altered rocks correlates with the amount of oxygen isotope depletion measured in the rocks. Two units, the caldera-fill Sunshine Peak Tuff and the Precambrian Granite of Cataract Gulch outside the southwest margin of the caldera ring fault, are both mineralogically uniform. The proportion of sanidine phenocrysts in tuff samples that has been altered to product phases was estimated and the whole-rock oxygen isotope composition of each sample was measured. Trajectories that mimic oxygen isotope water/rock ratio trajectories, calculated using the water/rock equations of Taylor (1977), were generated when the volume of sanidine alteration was plotted against the whole-rock oxygen isotope composition measured for each sample. A similar correlation was found for the Pre-cambrian granite when the amount of primary biotite altered to chlorite and sericite was used. These results show that both the quantity of mineral products and the amount of oxygen isotope depletion developed in a hydrothermal system are coupled functions of the progress of water/rock interaction. These relationships have been used to interpret the geometry of the Lake City hydrothermal system. The excellent documentation of mineral alteration and isotope depletion in this system provides a unique opportunity to test geochemical modeling codes in a natural hydrothermal system.

47062 (CONF-8609134–, pp. 72-79) **Application of EQ3/6 to modeling the chemical evolution in hydrothermal systems: An example at the Valles Caldera, N.M.** White, A.F. (Univ. of California, Berkeley (USA)); Chuma, N.J. Lawrence Livermore National Lab., CA (USA). 1986. From Workshop on geochemical modeling; Fallen Leaf Lake, CA (USA); 14-17 Sep 1986. In *Proceedings of the workshop on geochemical modeling.* Order Number DE89008807/JAW. Available from NTIS, PC A09/MF A01.

A kinetic-equilibrium reaction path model, utilizing the EQ3NR/EQ6 computer code, is produced for the central 300°C hydrothermal reservoir and the associated hot spring system in the Valles Caldera, New Mexico, US. An average rock-water ratio of 0.7 kg × kg^{-1}, a total reaction time of 2.9×10^5 years, and a fluid residence time of 1.9×10^3 years are calculated for the system based on ^{18}O and Li mass balances and fluxes. A low reactive surface area of $6.15 \times 10^2 cm^2 \times kg^{-1}$, derived with a hydrothermal kinetic rate expression, implies a fracture dominated system controlled in part by diffusion. The reservoir fluid chemistry and secondary mineral assemblage are successfully reproduced by the model using only one fitting parameter, the mass of carbon derived from underlying Paleozoic rocks. The fluid-mineral chemistry is fixed based on phase rule constraints and is controlled by chloride sources in the primary glass phase and by temperature.

47063 (CONF-8609134–, pp. 80-85) **Serpentinization reaction pathways: Implications for modeling approach.** Janecky, D.R. (Los Alamos National Lab., NM (USA)). Lawrence Livermore National Lab., CA (USA). 1986. From Workshop on geochemical modeling; Fallen Leaf Lake, CA (USA); 14-17 Sep 1986. In *Proceedings of the workshop on geochemical modeling.* Order Number DE89008807/JAW. Available from NTIS, PC A09/MF A01.

Experimental seawater-peridotite reaction pathways to form serpentinites at 300°C, 500 bars, can be accurately modeled using the EQ3/6 codes in conjunction with thermodynamic and kinetic data from the literature and unpublished compilations. These models provide both confirmation of experimental interpretations and more detailed insight into hydrothermal reaction processes within the oceanic crust. The accuracy of these models depends on careful evaluation of the aqueous speciation model, use of mineral compositions that closely reproduce composition in the experiments, and definition of realistic reactive components in terms of composition, thermodynamic data, and reaction rates.

47064 (CONF-8609134–, pp. 103-110) **Modeling mass transfer reaction rates: Calcite precipitation and CO_2 outgassing in a Karst steam.** Herman, J.S. (Univ. of Virginia, Charlottesville (USA)); Lorah, M.M. Lawrence Livermore National Lab., CA (USA). 1986. From Workshop on geochemical modeling; Fallen Leaf Lake, CA (USA); 14-17 Sep 1986. In *Proceedings of the workshop on geochemical modeling.* Order Number DE89008807/JAW. Available from NTIS, PC A09/MF A01.

While theoretical and experimental studies are widely reported in the geochemical kinetics literature, field studies are relatively few in number. In this study, the evolution of water chemistry along a well-defined flow-path was quantified by modeling the mixing of two discrete waters and mass transfer reactions between sampling points using WATEQF and PHREEQE and observed chemical compositions. The reaction time between sampling locations was estimated from measurements of stream discharge and geometry. The major reactions considered were CO_2 outgassing and calcite precipitation from ground and surface waters in a limestone terrane. The kinetics of calcite dissolution and precipitation have been especially well-studied, and the reaction rates obtained from the combination of the mass transfer modeling and hydrologic measurements of this study could be compared with the rates predicted from a laboratory-derived rate law. The agreement in rates was generally within an order of magnitude and routinely within a factor of 2 or 3. Least agreement between measured and predicted rates was obtained for sections of flow-path where relatively little change in bulk chemical composition occurred, which were the sections with the greatest mass transfer modeling error. For the travertine-depositing stream of Warm River Cave and Falling Spring Creek, VA, the coupling of equilibrium speciation and mass transfer geochemical models with simple field measurements in a hydrologically well-defined system allowed successful field-based quantification of reaction rates.

47065 (CONF-8609134–, pp. 111-119) **Predicting mineral dissolution and precipitation during burial: Synthetic diagenetic sequences.** Bruton, C.J. (Lawrence Livermore National Lab., CA (USA)). Lawrence Livermore National Lab., CA (USA). 1986. From Workshop on geochemical modeling; Fallen Leaf Lake, CA (USA); 14-17 Sep 1986. In *Proceedings of the workshop on geochemical modeling.* Order Number DE89008807/JAW. Available from NTIS, PC A09/MF A01.

Diagenetic changes with depth, reflecting the influence of source terrane, depositional environment and burial history, can be simulated using the EQ3/6 geochemical model of fluid-rock interaction. Synthetic diagenetic sequences are constructed by simulating reaction between rocks and pore fluids during burial and tracking mineral precipitation and dissolution events that occur as the rock and fluid attempt to come to equilibrium with each other. Four representative rock compositions, including a quartzose sandstone, two quartzofeldspathic sandstones and a volcanic sandstone, were chosen to simulate the control of source terrane on diagenesis. Using EQ3/6, the rocks were reacted with representative river and sea water to study the influence of fresh water and marine depositional environments, respectively, on diagenesis. The rock-fluid system was assumed to be closed. A burial rate of 0.07 mm/yr along a geothermal profile with a gradient of 30°C/km, which was chosen to simulate present-day conditions in the Texas Gulf Coast, was modeled. Rates of mineral dissolution were calculated in three different manners for comparison: (1) linear arbitrary kinetics; (2) zeroth order kinetics; and (3) transition state theory assuming pH-independent rates. Subsequent fluid-rock reactions, including mineral precipitation, were assumed to be reversible and to occur

instantaneously. Simulation results indicate that the sequence of diagenetic events for reaction between a given rock and fluid is largely independent of the rate law used to describe mineral dissolution. Synthetic diagenetic sequences also agree reasonably well with observed diagenetic reactions in natural systems. Calculation of the absolute timing of diagenetic events, however, appears to depend on reactive surface area, precipitation kinetics, and other rate-limiting phenomena.

47066 (CONF-8609134–, pp. 184-188) **Chlorite solubility between 200°C and 350°C: An experimental and theoretical modeling study.** Thornton, E.C. (Univ. of Minnesota, Minneapolis (USA)); Seyfried, W.E. Jr.; Seewald, J. Lawrence Livermore National Lab., CA (USA). 1986. From Workshop on geochemical modeling; Fallen Leaf Lake, CA (USA); 14-17 Sep 1986. In *Proceedings of the workshop on geochemical modeling.* Order Number DE89008807/JAW. Avaiiable from NTIS, PC A09/MF A01.

Computer modeling of rock/water interaction processes can contribute greatly to their understanding of mineral alteration and mass transport in hydrothermal systems. These models, however, may be applied in a quantitative manner only if one has accurate thermodynamic data for the solubilities of common rock-forming minerals. Currently, solubilities of many minerals can only be approximated owing to a lack of experimental data at the appropriate conditions. The authors present here recently acquired solubility data for chlorite and illustrate how it may be integrated into a computer model for rock/water interaction.

17 WIND ENERGY

1706 Wind Energy Engineering

47067 (ECN–217) **Recommendations for a European wind turbine standard on performance determination.** Curvers, A.; Pedersen, T.F. Netherlands Energy Research Foundation, Petten (Netherlands). Jul 1989. 65p. Available from Netherlands Energy Research Foundation ECN, P.O. Box 1, 1755 ZG Petten, Netherlands.

Within the framework of a uniform development of licensing criteria and certification procedures for wind turbines within the European Communities, CEC has commissioned a contract to a group of European wind turbine test stations (ECN, Risoe, CWD, NEL, VUB, WISA) to set up a set of recommendations for a European wind turbine standard on performance determination. The present recommendations are based on the established experiences of the test stations involved, on existing standards (IEA, AWEA, CSA) and on a CEC study on accuracy of power curve measurements. In comparison with the existing standards the most important differences are: the total measurement time is proposed to be dependent on a minimum number of data sets per bin and a 1% statistical uncertainty in the annual energy output due to wind variability; the required accuracies of the measurement instrumentation and signal conditioning have been strengthened; it has been recommended to apply different correction procedures on air density variation, for stall regulated wind turbines; the analyses of instrument uncertainties and the statistical error due to wind variability have been adopted in the recommendations. The testing procedure has been adjusted to the above mentioned changes.

47068 (ECN–218) **Error analysis in the determination of the power performance of wind energy conversion systems.** Dragt, J.B. Netherlands Energy Research Foundation, Petten (Netherlands). May 1989. 32p. Available from Netherlands Energy Research Foundation ECN, P.O. Box 1, 1755 ZG Petten, Netherlands.

An overview of error evaluation for power performance measurements of wind turbines is given. It concentrates on the effects of the following error sources: inaccuracies in measured output power or in air density, uncertainties in wind speed due to anemometer inertia, instrument calibration, quantisation (finite bin width), and lack of representativity of the anemometer due to terrain irregularities or due to local wind variation between anemometer and wind turbine. In every case the resulting statistical uncertainty or estimation bias is considered for both the power curve and the annual energy production of the wind turbine. The study has been carried out in the framework of a CEC project on standardization of performance measurements. 8 refs.

47069 (ETDE-mf–0702692) **Measurements on the AEOLUS 11 wind power plant and comparison with rated loads.** Matthies, H.; Mueller, R.; Siegfriedsen, S. Germanischer Lloyd, Hamburg (Germany, F.R.); Aerodyn-Energiesysteme, Damendorf (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). Oct 1986. 249p. (In German). Contract BMFT KFA 03E-8384-A. Order Number DE90702692/JAW. Available from NTIS (US Sales Only), PC A11/MF A01.

Appendix in separate volume.

This interim report of the research project 'Evaluation of Rules for the Examination, Approval and Inspection of Wind Energy Convertors' contains the results of the investigations performed for a pitch-controlled two-blade machine. Data of the first measurement campaigns and the following bulky analyses of those data are compared to the preliminary, simplified load assumptions of the rules for wind energy convertors of the state Schleswig-Holstein. In addition, comparison is made between measured loads of components and the design loads calculated by the manufacturer. The loads of the rotor blades and the tower are recorded directly for the analysis whereas the loads in components which cannot be equipped with measuring gauges are evaluated theoretically. The results of the analyses of the measurements are presented and are discussed in comparison to the simplified load assumptions if necessary. The tools for measurement and successive analysis are layed out to show the flow of data from pick up to printed result. (orig.).

47070 (ETDE-mf–0702695) **Utilization of small wind energy converters in the Federal Republic of Germany. Final report.** Amann, T.; Knuenz, D. M.A.N. Technologie G.m.b.H., Muenchen (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). Aug 1988. 225p. (In German). Contract BMFT 03E-8050-A. Order Number DE90702695/JAW. Available from NTIS (US Sales Only), PC A10/MF A01.

The decentralized utilization of small wind energy converters for the domestic power production of single households/farms parallel to the public grid has hardly been tested in practice up to now in the Federal Republic of Germany. Amongst others, the following points should lead to new experience in the demonstration programme: requirements for the building permit, erection and grid-connection of small wind energy converters and determination of the resulting costs; achievable cost reduction of wind energy converters by small-series-production; long-term experience from a 2-years'-operation of identical plants by independent, non-scientific operators. For that reason, 20 wind energy converters, type AEROMAN 12/20, were built and installed at 20 selected sites. (orig./HW) With 6 tabs., 45 figs.

47071 (ETDE-mf–0702726) **Development of a wind energy system for generating electrical energy in developing countries in the power range from 5 to 8 kW. Final report.** Blaser, P.; Gering, T.; Kniehl, R.; Kunzmann, K.; Schoeberl, W.; Wurz, D. Karlsruhe Univ. (T.H.) (Germany, F.R.). Inst. fuer Technische Thermodynamik; Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). Jun 1989. 67p. (In German). Contract BMFT 03E-8304-A. Order Number DE90702726/JAW. Available from NTIS (US Sales Only), PC A04/MF A01.

Within the framework of the research project a wind energy system working at a rated power of 8 KW was developed. The system generates AC at constant frequency in insolated operation. Therefore all kinds of electrical consumers can generally be supplied. The application of a wind energy system of this size will e.g. be interesting with electrical water pumps or as a 'fuel saver'. A contract for cooperation and transfer of technology was effected with an industrial enterprise. The performances which the partner in cooperation was guaranteed were carried out according to the arrangements. A complete and detailed documentation of the wind energy system is attached. At the end of the project a small wind energy system for application in isolated operation is available. It is manufactured and commercialized by an industrial enterprise. (orig.) With 11 refs., 1 tab., 39 figs.

47072 (ETDE-mf–0702817) **BERWIAN: Development, construction and operation of a new type of wind power plant with**

vortex screw focusser (phase 1). Rechenberg, I. Technische Univ. Berlin (Germany, F.R.). Fachgebiet Bionik und Evolutionstechnik; Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 1988. 47p. (In German). Contract BMFT 03E-8412A. Order Number DE90702817/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

One is of the opinion nowadays that one cannot have genuine physical wind energy amplifiers, but one can obtain wind energy focussers. The aim is not more energy, but the conversion of wind at low speed (over a large area) to a high speed (over a small area). Energy focussing reduces machine construction costs, as the trend of development in powered machine construction shows. The first part of the report is concerned with the results of the development work of phase 1 of the Berlin 'Berwian' wind powerplant. It introduces the aims of power, the results of a first industrial economy study and the course of outdoor experiments at Fehmarn from 1984 to 1986. In the second part, the development of the idea to the prototype is described and in the third part, the size and optimum configuration of the Berwian is dealt with, in comparison with conventional wind turbines. (BR).

47073 (PNL–6959) **User's guide for a personal computer model of turbulence at a wind turbine rotor.** Connell, J.R.; Powell, D.C.; Gower, G.L. Pacific Northwest Lab., Richland, WA (USA). Aug 1989. 170p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC06-76RL01830. Order Number DE89017753/JAW. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

This document is primarily (1) a user's guide for the personal computer (PC) version of the code for the PNL computational model of the rotationally sampled wind speed (RODASIM11) and (2) a brief guide to the growing literature on the subject of rotationally sampled turbulence, from which the model is derived. The model generates values of turbulence experienced by single points fixed in the rotating frame of reference of an arbitrary wind turbine blade. The character of the turbulence depends on the specification of mean wind speed, the variance of turbulence, the crosswind and along-wind integral scales of turbulence, mean wind shear, and the hub height, radius, and angular speed of rotation of any point at which wind fluctuation is to be calculated. 13 refs., 4 figs., 4 tabs.

20 ELECTRIC POWER ENGINEERING

Refer also to citation(s) 47767

2001 Power Plants and Power Generation

Refer also to citation(s) 46823, 46879, 47281, 47764

47074 (DOE/MC/21023–2716) **Second-generation pressurized fluidized bed combustion plant conceptual design: Phase 1, Task 1, Executive summary.** Robertson, A.; Garland, R.; Newby, R.; Rehmat, A.; Rubow, L. Foster Wheeler Development Corp., Livingston, NJ (USA). Jun 1989. 31p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-86MC21023. Order Number DE89011670/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The electric utility industry needs a new generation of plants that can operate with substantially improved efficiencies and availabilities, accept lower-quality fuels, and easily meet present and future New Source Performance Standards (NSPS). The plants should be low in capital costs, have short design and construction lead times, be highly reliable/available, and be amenable to modularity – all leading to a lower cost of electricity (COE) and a lower risk of surplus capacity. In response to this need, a team of companies led by Foster Wheeler Development Corporation has embarked upon a DOE-funded three-phase 5-year program to develop the technology for this new type of plant. Quantitatively, the targeted goals for this new plant are a COE at least 20-percent lower than that of a conventional pulverized-coal-(PC)-fired plant with a stack gas scrubber and a 45-percent efficiency (based on the higher heating value of the coal). During the first phase, the plant will be conceptually designed, the parameters that optimize performance and have a significant impact on COE will be determined, and commercialization and research and development plans will be formulated. In Phase 2 the key components of the plant will be individually tested at the laboratory scale; performance data will be correlated; and the Phase 1 design, cost estimate, and plans will be updated. In Phase 3 the key components will be tested as a fully integrated subsystem at the 5-MWe equivalent scale, system and performance characteristics will be correlated, and the Phase 2 designs and cost estimates will be updated. This report was prepared as a part of the Phase 1 effort; it presents the conceptual design of the plant and the results of optimization and COE sensitivity studies, and it reveals that the proposed plant will meet the targeted goals. 15 refs., 5 figs., 5 tabs.

47075 (IVO-B–04/89) **Service life assesment and examination of concrete structures in renovation.** Huovinen, P.; Ipatti, A.; Nikkari, E. Imatran Voima Oy, Helsinki (Finland). Jun 1989. 52p. (In Finnish). Order Number DE89914699/JAW. Available from NTIS (US Sales Only), PC A04/MF A01.

As power plants are ageing, the number of repairs and renovations is strongly increasing. However, no clear instructions for determining the present condition of the concrete structures and for assessing the service life of the structures are available. On the basis of literary references, directives have been drawn up. By means of these directives, the present condition of the concrete structures can be determined and their service life assessed as reliably as possible. On grounds of the directives, the maintenance staff of the operational district can assess the present condition of the structures and carry out a damage mapping. On the other hand, the construction designers can assess the residual service life of the structures. Then, it is possible to choose the optimum repair times. In the beginning of the report, the basics of the service life thinking of concrete structures will be created, and the factors affecting the service life assessment will be studied. the report emphasizes particularly the frost scaling of concrete and the corrosion of reinforcing steels which are the main deteriorating factors limiting the service life of structures in Finland. the service life determinations have been illustrated by calculation examples. The end of the report includes the principles of the damage mapping and determination of the condition of concrete sructures. It also includes usable research methods and instruments for assessment of the structural condition.

47076 **Market assessment for hydrogen from the catalyzed gasification of low-rank coals.** Sinor, J.E. (Sinor (J.E.) Consultants, Inc., Niwot, CO (USA)). pp. 112 of Technical economics, synfuels, and coal energy. 1989. Dicks, J.B. American Society of Mechanical Engineers, New York, NY (1989). (CONF-8901108–: Technical economics, synfuels, and coal energy, Houston, TX (USA), 22-25 Jan 1989).

A market assessment was carried out for applications for the high-hydrogen-content gas which can be made via the catalyzed gasification of low-rank coals. The coproduction of methanol and electricity is estimated to be cost-competitive in the near future. A unique application is defined which would couple the coal gasifier directly to a molten carbonate fuel cell with an overall fuel-to-electricity efficiency of about 60 percent.

47077 **A supplementary adaptive var unit controller for power system damping.** Smith, J.R. (Montana State Univ., Bozeman, MT (USA). Dept. of Electrical Engineering); Pierre, D.A.; Sadighi, I.; Nehrir, M.H.; Hauer, J.F. *IEEE Transactions on Power Systems (USA)*, 4(3): 1017-1023 (Aug 1989).

This paper describes a multivariable adaptive LQ control strategy for static var compensators (SVC's) which can be added to a fixed controller already present in order to enhance the robustness and effectiveness of the var unit in damping power system oscillations. The control strategy uses only local network information to damp oscillations between machines in the network. Simulation results are presented on a nine-bus network. The controller is effective in reducing local machine oscillations even in cases where the oscillatory disturbance is not controllable.

2002 Environmental Control Technology

Refer also to citation(s) 46840, 47074

47078 (CONF-890815–27) **System simulation and comparison of advanced flue gas clean-up processes in coal-fired power plant using salt code.** Chang, S.L.; Berry, G.F.; Hu, N. Argonne National Lab., IL (USA). 1989. 7p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. From 24. intersociety energy conversion engineering conference; Arlington, VA (USA); 6-11 Aug 1989. Order Number DE89017681/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Coal-fired power plants have been using conventional wet limestone flue gas desulfurization device to remove about 50% of sulfur from the flue gas and meet the pollutant emission standards. As the emission standards become more stringent, many advanced flue gas clean-up (FGC) processes capable of removing over 90% of both pollutants SOx and NOx are being developed. To help the industry select an advanced FBC process that is economically affordable and meets the new emission standards, a common base is required to evaluate performances and costs of these advanced FGC processes. Computer simulation provides a simple, fast and effective common base. This paper reports the use of the System Analysis Language Translator (SALT) computer code to evaluate the clean-up performance and cost of several advanced FGC processes, including fluidized-bed copper oxidization, fluidized-bed sodium absorption, electron beam/spray dryer and electron beam/ammonia injection processes. 13 refs., 6 figs., 2 tabs.

47079 (IVO-B–03/89) **Report on on-line pulverized coal flow meters.** Lepikko, J. Imatran Voima Oy, Helsinki (Finland). Jun 1989. 53p. (In Finnish). Order Number DE89914700/JAW. Available from NTIS (US Sales Only), PC A04/MF A01.

In the future the need for optimizing the operation of power plant boilers and the more and more stringent requirements concerning emissions may call for on-line burner-specific fuel flow measurement in pulverized fuel boilers, and connection of this measurement in pulverized fuel boilers and connection of this measurement to be part of the boiler's control system. This task can be perfomed only with reliable on-line flow meter and control equipment which can stand demanding operating conditions. Flow meter for pulverized coal in coal feed pipes are not yet available commercially for the power plant, but number of instrument concepts have been suggested and are in various stages of development. An overview of some of the more promising approaches are presented in this report. This report is based on litterature, patent application and own testing experiences. In addition, a report on pulverized coal flow measuring facilities on the Japanese market has been bought. The mos promising techniques for the measurement of pulverized coal flow rate in the fuel pipes to the burners are the correlational and the ultrasonic Doppler methods. Also, methods utilizing the so called acoustic resonance seem to be particularly promising, since they enable both on-line measurement of particle loading and particle size distribution of pulverized coal.

2003 Power Transmission and Distribution

47080 (DOE/BP–972) **The impact of performance standards on the uncertainty of the Pacific Northwest electric system: A final report on the hypersens analysis of CPAM [Conservation Policy Analysis Model].** Ford, A.; Geinzer, J. University of Southern California, Los Angeles, CA (USA). Inst. of Safety and Systems Management; Applied Energy Services, Inc., Arlington, VA (USA). Energy Planning Services Dept. Feb 1988. 30p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC79-85BP24760. Order Number DE89017648/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report describes the findings from a detailed analysis of the long term uncertainty of the Pacific Northwest electric system. The purpose of the study is to quantify the extent to which performance standards for new homes and buildings reduce the uncertainty in the system. We demonstrate that standards make the system more predictable and thereby reduce the cost of insurance needed to defend against uncertainty. 7 refs., 20 figs.

47081 (EPRI-EL–6429) **Substation evaluation using Diagnostic Logic System (DIALOG).** Andre, W.L. Electric Power Research Inst., Palo Alto, CA (USA); Andtek, Inc., Huntsville, AL (USA). c Aug 1989. 140p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This project investigated the feasibility of applying a Diagnostic Logic System (DIAGLOG) to evaluate substation operation. The purpose was to see if a determination can be made as to whether the equipment in a substation operated correctly or not when an operating event occurred. The work was directed toward modifying an already proven diagnostic system to create a simplified procedure for describing the operation of substation equipment. Special operating tables or modules of logic were identified for describing relay and breaker operations. The resulting model composed of all the modules connected together is used to evaluate the actual observations available at the substation, and to compare them with what the substation should have produced. The report covers the diagnostic approach used, information on how to construct the modules and examples of diagnosis. Also covered are discussions on the special features of substations that offer a challenge to performing diagnostics. Included in the report are the results of modeling a typical substation and several notes are provided along with an initial library of typical modules which were developed in modeling one of the substations belonging to the Pacific Gas and Electric Company. This substation served as a feasibility demonstrator. 15 figs.

47082 (IVO-A–05/89) **Transient phenomena in asynchronous motor drive.** Hirvonen, R. Imatran Voima Oy, Helsinki (Finland). Jun 1989. 69p. (In Finnish). Order Number DE89914698/JAW. Available from NTIS (US Sales Only), PC A04/MF A01.

Transient torques of a motor drive cause torsional stresses in the shaft. Motor is constructed to withstand these torques. In construction of couplings, shaft and drive these torques have to be taken into consideration, too. Transient phenomena are simulated by EMTP-program. The dynamic behaviour of asynchronous machine is modeled by UM-model of EMTP-program. In this report it has been investigated the application of EMTP-program in calculation of transient phenomena of asynchronous machine. The structure of UM-model and its connection to EMTP-program is presented in the chapter 1. The saturation of machine can be simulated by TACS-model of EMTP. Simulations made by others using UM-mocel are in the chapter 2. Comprisons between calculated and measured values are presented. The simulations made during this investigation are presented in the chapter 3. The simulated transient phenomena were: starting, three phase short circuit and fast bus transter. Simulations have been compared with values given by motor manufacturers. According to these calculations EMTP-program can be used in simulations of transient phenomena in asynchronous machines. Improvements presented in the chapter 3.7 can increase the accuracy of simulations.

21 NUCLEAR POWER PLANTS

Refer also to citation(s) 47142

47083 (IAEA-TECDOC–505) **Analysis and management of risks from the nuclear fuel cycle. Final report of the coordinated research programme on development of risk criteria for the nuclear fuel cycle.** International Atomic Energy Agency, Vienna (Austria). Apr 1989. 137p. Order Number DE90601635/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

The Coordinated Research Programme (CRP) on Risk Criteria for the Nuclear Fuel Cycle was begun in 1983 with several objectives: A primary objective was to permit countries with little experience with risk assessment methods to gain familiarity with these techniques. Another objective was to support work regarding safety criteria complementary to the risk assessment work. Risk criteria expressed as quantitative safety goals or targets can be used to establish acceptable safety levels; in this respect, they define what it is that risk assessments should measure; conversely the capabilities of risk assessment must be recognized when risk criteria are established. In addition to the work by each participating country under the sponsorship of the programme, the exchange of information between the participants was an objective of the programme. Refs, figs and tabs.

2101 Power Reactors, Non-breeding, Light-water Moderated, Boiling Water Cooled

Refer also to citation(s) 47090, 47092, 47094, 47105, 47110, 47137, 47139, 47140, 47144, 47146, 47151, 48744

47084 (CONF-8907137–1) **Thermal aging of some decommissioned reactor components and methodology for life prediction.** Chung, H.M. Argonne National Lab., IL (USA). Mar 1989. 45p. Sponsored by Nuclear Regulatory Commission. DOE Contract W-31109-ENG-38. From Symposium on plant life extension for nuclear components; Honolulu, HI (USA); 24-27 Jul 1989. Order Number DE89016906/JAW. Available from NTIS, PC A03/MF A01; OSTI, INIS; GPO Dep.

Since a realistic aging of cast stainless steel components for end-of-life or life-extension conditions cannot be produced, it is customary to simulate the thermal aging embrittlement by accelerated aging at ~400°C. In this investigation, field components obtained from decommissioned reactors have been examined after service up to 22 yr to provide a benchmark of the laboratory simulation. The primary and secondary aging processes were found to be identical to those of the laboratory-aged specimens, and the kinetic characteristics were also similar. The extent of the aging embrittlement processes and other key factors that are known to influence the embrittlement kinetics have been compared for the decommissioned reactor components and materials aged under accelerated conditions. On the basis of the study, a mechanistic understanding of the causes of the complex behavior in kinetics and activation energy of aging (i.e., the temperature dependence of aging embrittlement between the accelerated and reactor-operating conditions) is presented. A mechanistic correlation developed thereon is compared with a number of available empirical correlations to provide an insight for development of a better methodology of life prediction of the reactor components. 18 refs., 18 figs., 5 tabs.

47085 (IWGFPT–31) **Burnup determination of water reactor fuel. Proceedings of a technical committee meeting held in Karlsruhe, 13-16 June 1988.** International Atomic Energy Agency, Vienna (Austria). International Working Group on Water Reactor Fuel Performance and Technology. May 1989. 87p. (CONF-8806392–: IAEA technical committee meeting on burnup determination of water reactor fuel, Karlsruhe (Germany, F.R.), 13-16 Jun 1988). Order Number DE90601639/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

The present meeting was scheduled by the International Atomic Energy Agency in consultation with the Members of the International Working Group on Water Reactor Fuel Performance and Technology. The meeting was hosted by the Commission of the European Communities, at the Transuranium Research Laboratory, Joint Research Centre Karlsruhe, in the Federal Republic of Germany. This subject was dealt with for the first time by the IAEA. It was found to correspond adequately to this type of Specialist Meeting and to be suitable at a moment when the extension of burnup constitutes a major technical and economical issue in fuel technology. It was stressed that analysis of highly burnt fuels, mixed oxides and burnable absorber bearing fuels required extension of the experimental data base, to comply with the increasing demand for an improved fuel management, including better qualification of reactor physics codes. Twenty-seven participants from eleven countries plus two international organizations attended the Meeting. Twelve papers were given during three technical sessions, followed by a panel discussion which allowed to formulate the conclusions of the meeting and recommendations to the Agency. In addition, participants were invited to give an outline of their national programmes, related to Burnup Determination of Water Reactor Fuel. A separate abstract was prepared for each of these 12 papers. Refs, figs and tabs.

47086 (IWGFPT–31, pp. 85) **IAEA in-core fuel management activities.** Crijns, M. (International Atomic Energy Agency, Vienna (Austria). Div. of Nuclear Power). International Atomic Energy Agency, Vienna (Austria). International Working Group on Water Reactor Fuel Performance and Technology. May 1989. (CONF-8806392–: IAEA technical committee meeting on burnup determination of water reactor fuel, Karlsruhe (Germany, F.R.), 13-16 Jun 1988). In *Burnup determination of water reactor fuel. Proceedings of a technical committee meeting held in Karlsruhe, 13-16 June 1988.* Order Number DE90601639/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

Published in summary form only.

47087 (ORNL/FTR–3105) **[Reliability of reactor pressure components]: Foreign trip report, October 16–21, 1988.** Pugh, C.E. Oak Ridge National Lab., TN (USA). 4 Nov 1988. 22p. Sponsored by DOE/NE;NRC. DOE Contract AC05-84OR21400. Order Number DE89017386/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler attended the regularly scheduled meeting of the IAEA IWG-RRPC as the US representative. The IWG-RRPC addresses R and D programs in the member countries relative to the reliability of passive and active pressure components of nuclear reactors. While not limited to light-water reactors (LWRs), most ongoing activities are supported by LWR programs. The scientific secretary reported the four Specialists' Meetings and one training course held since the last IWG meeting. Three Specialists' Meetings were identified for each of the next four years, with one planned to be held in the United States in 1991. Twenty-seven representatives from seventeen countries and two allied international programs attended the meeting. The traveler presented a summary of R and D programs in the United States with an emphasis on those of the Nuclear Regulatory Commission (NRC). The traveler has copies of handouts from other representatives at ORNL. The current RRPC Scientific Secretary completes his assignment in December 1988, and his replacement will be in place prior to the next IWG meeting. 5 refs.

47088 (SAND–88-1881C) **Operational data collection and analysis for nuclear plant life extension.** DuCharme, A.R.; Berg, R.M,.; Bailey, T.L. Sandia National Labs., Albuquerque, NM (USA). 1989. 8p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC04-76DP00789. (CONF-890911–3: International conference on operability of nuclear systems in normal and adverse environments, Lyon (France), 18-22 Sep 1989). Order Number DE89011538/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper describes initial work undertaken by the US Department of Energy, through Sandia National Laboratories in Albuquerque, New Mexico, to define the operational data necessary for support of nuclear plant life extension (PLEX) programs. This work is being performed in coordination with the Working Group on Plant Life Extension of the US Nuclear Management and Resources Council. The intent of the effort is to use results gained initially from pilot PLEX programs a US BWR and a US PWR to build towards the use of "PLEX indicators" by which a plant's readiness for successful life extension can be measured. Another objective of the study was to examine chemistry data in detail to determine how well US plants are collecting, preserving, and trending the chemistry data that is important to PLEX. The methods used to disseminate this data to outside agencies and other utilities were studied. Finally, an analysis was made to determine additional chemistry data needed to support PLEX.

2102 Power Reactors, Non-breeding, Light-water Moderated, Non-boiling Water Cooled

Refer also to citation(s) 47084, 47085, 47086, 47087, 47088, 47105, 47116, 47134, 47136, 47137, 47139, 47140, 47144, 47146, 47150, 47151, 47155, 47165, 47167, 47168, 47169, 47170, 47171, 47172, 47173, 47174, 47175, 47176, 47177, 47178, 47179, 47180, 47181, 47182, 47183, 47184, 47185, 47186, 47187, 47188, 47189, 47190, 47191, 47192, 47193, 47194, 47195, 47196, 47197, 47198, 47200, 47478, 47731, 48744

47089 (IWGFPT–31, pp. 39-44) **Non-destructive burnup determination: Experimental investigation on low burnup gadolinia fuel.** Blanpain, P. (Societe Belge pour l'Industrie Nucleaire, Brussels (Belgium)); Leenders, L.; Zwicky, H.U. International Atomic Energy Agency, Vienna (Austria). International Working Group on Water Reactor Fuel Performance and Technology. May 1989. (CONF-8806392–: IAEA technical committee meeting on burnup determination of water reactor fuel, Karlsruhe (Germany, F.R.), 13-16 Jun 1988). In *Burnup determination of water reactor fuel. Proceedings of a technical committee meeting held in Karlsruhe, 13-16*

June 1988. Order Number DE90601639/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

Neutronic codes benchmarking based on irradiated fuel rods needs a scale factor in order to compare calculated data with experimental results. A rod-to-rod non destructive, low cost burnup measurement with accuracies comparable with the accuracy of the ^{148}Nd radiochemical method provides the wanted check. The "Burnotheque" method developed by the SCK/CEN physics group, consists in comparing the ^{137}Cs activity of the examined fuel rod with that of standard burnup samples. That comparison takes into account the decay correction during and after irradiation, the mass of investigated fuel material and shielding effects due to the eventual fuel density or cladding material differences. The reliability and the limitation of the method will be discussed as well as recent data obtained in the framework of the "International Experimental Programme on Gadolinia Fuel Evolution in PWRs (GAP)". Seventeen absolute burnup results are compared to radiochemical and calculated values emphasizing the particular problems related to the low burnup gadolinia fuel rods. (author). 3 refs, 4 figs, 1 tab.

47090 (IWGFPT–31, pp. 44-51) **Techniques and equipment for determination of fuel burnup in water cooled reactors.** Ljadov, G.D. (Nauchno-Issledovatel'skij Inst. Atomnykh Reaktorov, Dimitrovgrad (USSR)); Dvoretskij, V.G.; Smirnov, V.P.; Aleksandrov, K.A.; Chetverikov, A.P. International Atomic Energy Agency, Vienna (Austria). International Working Group on Water Reactor Fuel Performance and Technology. May 1989. (CONF-8806392–: IAEA technical committee meeting on burnup determination of water reactor fuel, Karlsruhe (Germany, F.R.), 13-16 Jun 1988). In *Burnup determination of water reactor fuel. Proceedings of a technical committee meeting held in Karlsruhe, 13-16 June 1988.* Order Number DE90601639/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

This report involves methods and equipment to determine the burnup of fuel for water-cooled reactors. The mass- and gamma-spectrometric data for determining the burnup of fuel in the VK-50 BWR are given as an example. The burnup distribution and "hardness" parameter of neutron spectrum with height and section of fuel assembly (FA) have been measured by nondestructive test (NDT) of gamma-scanning. (author). 6 refs, 9 figs, 2 tabs.

47091 (IWGFPT–31, pp. 51-56) **Passive neutron verification of WWER-440 spent fuel burnup.** Vlaskin, G.N. (Vsesoyuznyj Nauchno-Issledovatel'skij Inst. Neorganicheskikh Materialov, Moscow (USSR)); Chvankin, E.V. International Atomic Energy Agency, Vienna (Austria). International Working Group on Water Reactor Fuel Performance and Technology. May 1989. (CONF-8806392–: IAEA technical committee meeting on burnup determination of water reactor fuel, Karlsruhe (Germany, F.R.), 13-16 Jun 1988). In *Burnup determination of water reactor fuel. Proceedings of a technical committee meeting held in Karlsruhe, 13-16 June 1988.* Order Number DE90601639/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

This paper presents a method based on passive neutron verification. The method is based upon calculation of the specific neutron emission rate as a function of burnup. It provides the basis for the construction of a burnup-meter. (author). 11 refs, 5 figs, 1 tab.

47092 (IWGFPT–31, pp. 57-66) **Non-destructive measurements of water reactor fuel and evaluation of measurement techniques for improved assay accuracy.** Simon, G.G. (Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Neutronenphysik und Reaktortechnik); Wuerz, H. International Atomic Energy Agency, Vienna (Austria). International Working Group on Water Reactor Fuel Performance and Technology. May 1989. (CONF-8806392–: IAEA technical committee meeting on burnup determination of water reactor fuel, Karlsruhe (Germany, F.R.), 13-16 Jun 1988). In *Burnup determination of water reactor fuel. Proceedings of a technical committee meeting held in Karlsruhe, 13-16 June 1988.* Order Number DE90601639/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

The assay is based on active and passive neutron detection. To demonstrate the method, several extensive series of measurements have been undertaken in storage ponds at reprocessing plants and power reactors. Uranium and MOX fuel elements have been assayed. It has been shown that the method applied can be used in reprocessing plants for determination of burnup and the type of fuel (Uranium or MOX). Due to the method's unique features it can also be used in reprocessing plants for criticality control and Pu input balance estimations. A combination of active-passive neutron and gross gamma measurements fulfills all requirements for fuel assemblies immersed in water. Without knowledge of any fuel assembly's data a complete identification of power reactor fuel is possible. The more simple passive neutron and gross γ-method allows a consistency check of the shipment data if and only if the fuel type is known. The demonstration program makes available calibration curves for criticality determination and representative burnup depends on neutron emission data for Uranium and MOX fuel or PWR and BWR power reactor having a cooling time above 2 years. It was further demonstrated to what extent the measurement is influenced by specific reactor parameters such as irradiation history and steam void. Both quantities have only minor influence for the assay of PWR fuel assemblies but have some consequences for BWR fuel. The knowledge acquired with the demonstration program was used to build a prototype incorporating all relevant features based on improved technical designs. Criteria for fulfilling stringent accuracy limits and for computerized control of these limits were established. After detailed laboratory tests, the prototype will undergo hot tests and routine measurement campaigns in storage ponds at reprocessing plants and power reactors. 10 refs, 11 figs, 2 tabs.

47093 (IWGFPT–31, pp. 67-70) **Experimental investigation of the radial fission product distribution in WWER fuel.** Polyakov, A.A. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Inst. Atomnoj Ehnergii); Komin, S.F.; Stogov, Yu.V.; Lunin, G.L.; Aborina, I.N.; Prosyolkov, V.N. International Atomic Energy Agency, Vienna (Austria). International Working Group on Water Reactor Fuel Performance and Technology. May 1989. (CONF-8806392–: IAEA technical committee meeting on burnup determination of water reactor fuel, Karlsruhe (Germany, F.R.), 13-16 Jun 1988). In *Burnup determination of water reactor fuel. Proceedings of a technical committee meeting held in Karlsruhe, 13-16 June 1988.* Order Number DE90601639/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

This paper presents experimental investigations for the determination of n,γ(U-238) and n,f(U-235) reaction rates in an elementary cell near the core performed at BOL. On the basis of this information the PU-239 buildup and U-235 fission rate were calculated and used as input in 2 DT calculations. These resulted in a 200 deg. C central temperature decrease (at about 448 W/cm MLHR). (author). 2 refs, 5 figs.

47094 (IWGFPT–31, pp. 70-72) **Burnup determination by the isotope correlation technique. Summary.** Koch, L. (Commission of the European Communities, Karlsruhe (Germany, F.R.). European Inst. for Transuranium Elements); Wellum, R. International Atomic Energy Agency, Vienna (Austria). International Working Group on Water Reactor Fuel Performance and Technology. May 1989. (CONF-8806392–: IAEA technical committee meeting on burnup determination of water reactor fuel, Karlsruhe (Germany, F.R.), 13-16 Jun 1988). In *Burnup determination of water reactor fuel. Proceedings of a technical committee meeting held in Karlsruhe, 13-16 June 1988.* Order Number DE90601639/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

The burnup of actinides and the consequent formation of fission products or higher actinides is inherently related. This can be expressed empirically by correlations, the basis for which has been proven theoretically. The burnup of the spent fuel can be obtained from the difference between the heavy nuclide concentrations before and after irradiation or from the amount of fission products formed relative to the initial actinides. There exists a third possibility which is exploited by the isotope correlation technique based on the buildup of isotopes by neutron capture. The buildup is proportional to the integrated neutron flux. This can be seen from changes in the isotopic ratio of plutonium, e.g. $^{242}Pu/^{240}Pu$ which increases proportionally to the burnup or for those fission-product ratios containing a nuclide with an appreciable neutron capture cross-section e.g. $^{131}Xe/^{132}Xe$. Even the recycling of Pu in thermal reactors is not prohibitive to the application of the isotope correlation technique. 11 refs, 4 figs, 1 tab.

47095 (JAERI-M–89-027) **ROSA-IV/LSTF 5% cold leg break LOCA experiment run SB-CL-18 data report.** Kumamaru, Hiroshige; Nakamura, Hideo; Hirata, Kazuo and others. Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1989. 111p. Order Number DE90701707/JAW. Available from NTIS (US Sales Only), PC A06/MF A01.

This report presents the experimental data obtained for 5 % cold leg break test with the assumption of high pressure injection system (HPIS) failure, Run SB-CL-18, conducted at the Large Scale Test Facility (LSTF) of the RCSA-IV program. In the test, core uncovery was observed twice. The first core uncovery occurred during loop seal clearing. The core uncovery was amplified by the manometric effect caused by imbalance in the coolant holdup in the steam generator (SG) U-tubes and SG plena between the upflow and downflow sides. The peak cladding temperature (PCT) in the test was observed during this temporary core uncovery just before the loop seal clearing. The second core uncovery occurred due to core boil-off; however, the core cooling was recovered after automatic actuation of the accumulators (ACC). This report includes all the data for the test. The experimental data are presented in engineering units. (author).

2103 Power Reactors, Non-breeding, Graphite Moderated

Refer also to citation(s) 47114, 47159, 47960, 47992

47096 (Juel–2277) **Polyphase diffusion of fission products in graphite. A contribution about the safety of high temperature reactors.** Dannert, V. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung. May 1989. 150p. (In German). Order Number DE90702785/JAW. Available from NTIS (US Sales Only), PC A07/MF A01.

The report attempts to give an introduction into the subject of fission product transport in nuclear graphite and results in an extended proposal of a transport-model. Beginning with a rough description of the graphite in question, an idea about the physical transport-phenomena in graphite is developed. Some of the basic experimental methods, especially techniques of porosimetry, determination of sorption-isotherms and of course several transport-experiments, are briefly described and their results are discussed. Some of the most frequent transport models are introduced and assessed with the criteria emphasized in this report. An extended model is proposed including the following main ideas: The transport of the fission-products is regarded as a two-phase-diffusion process through the open pores of the graphite. The two phases are: surface-diffusion and gas-diffusion. A time-dependent coupling of the two diffusion-phases by sorption-isotherms and a concentration-dependence of the surface diffusion coefficient, also related to the physical behaviour of the sorption-isotherms, are the basic properties of the proposed model. (orig./HP).

47097 (NUKEM-FuE–88034) **Reference elements for irradiation testing under THTR-follow-up plant conditions to determine safe fission product retention. Final report.** Mehner, A.W. Hochtemperatur-Reaktor-Brennelement G.m.b.H. (HOBEG), Hanau (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). Jul 1989. 38p. (In German). Contract BMFT 03 HOB 1135. Order Number DE90702801/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

During the project reference fuel elements with low enriched uranium (LEU) fuel elements designed for THTR-follow-up plants have been manufactured under conditions similar to a production line. These fuel elements have been irradiated under simulated power reactor conditions in a materials test reactor. To cover the whole band of expected deviations under simulated production conditions about 70 kg of uranium with 10,7% U-235 enrichment had to be provided. From this amount 50 kg of UO_2-kernels were manufactured. TRISO-coating was performed with eight batches of 5 kg each. From this material six 9 kg-batches were used for overcoating process. A representative amount of about 2 kg overcoated particles were taken to manufacture 150 fuel elements in the fuel element production facility. Remaining kernels were processed for storage. Remaining particles were stored for further applications. Fuel elements were characterized and a representative amount sent to KFA for irradiation. Characterization of fuel elements and their components showed very good agreements with the target specification. (orig.) With 9 refs., 10 tabs., 2 figs.

47098 (ORNL/FTR–2828) **[High temperature fuel behavior, fission products, and graphite]: Foreign trip report, March 5–13, 1988.** Kania, M.J. Oak Ridge National Lab., TN (USA). 28 Mar 1988. 17p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE89017287/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Travel to the Kernforschungsanlage (KFA)-Juelich described in this report was for the purpose of attending the Semiannual Management Meeting of the Fuel, Fission Products, and Graphite (FFPG) Subprogram. At this meeting highlights of the cooperative exchange were reviewed for the period from May 1987 through March 1988. The subprogram continues to be effective in strengthening the develor ent programs of both countries. Revision 13 of the FFPG Subprogram will be issued as a result of this meeting. An international workshop on high temperature fuel behavior was held at the KFA following the FFPG Subprogram Management Meeting. Workshop participants from Austria, Germany, and the United Kingdom presented their most resent results on fuel behavior based on fission product release obtained during isothermal heating tests and posttest examination of irradiated FRG fuels. The US/FRG cooperative effort on fuel performance modeling under accident conditions was presented by the traveler. The release data and modeling efforts presented at this workshop represent our present state-of-the-art knowledge on modern coated particle fuel behavior at high temperatures.

2105 Power Reactors, Breeding

Refer also to citation(s) 47131, 47132, 47133, 47145

47099 (CONF-890721–42) **A method for suppression of pressure pulses in fluid-filled piping: Theoretical analysis.** Shin, Y.W.; Wiedermann, A.H. Argonne National Lab., IL (USA). Jun 1988. 35p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From Joint ASME/JSME pressure vessel and piping conference; Honolulu, HI (USA); 23-27 Jul 1989. Order Number DE89016910/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS.

A simple, nondestructive method to suppress pressure pulses in a fluid-filled piping is theoretically analyzed, and the result provides the basis needed for design and evaluation of a pressure-pulse suppression device based on the proposed theory. The method is based on forming of fluid jets in the event of a pressure surge such that the pulse height as well as the energy of the pulse are reduced. The result for pressure pulses in the range of practical interest shows that a substantial reduction can be attained in the pulse height with accompanied reduction of pulse energy remaining in the system. The analysis also reveals that a certain amount of trade-off exists in the design of the suppression device; a certain level of pulse energy remaining in the system must be accepted in order to limit the pulse height below a certain level and vice versa. 7 refs., 5 figs.

47100 (ETEC-TDR–89-5) **Numerical simulation of a natural circulation decay heat removal experiment conducted at ETEC: Final report.** Banerjee, S.; Hetsroni, G.; Roy, C.M. Rockwell International Corp., Canoga Park, CA (USA). Energy Technology Engineering Center; California Univ., Santa Barbara, CA (USA). Dept. of Chemical and Nuclear Engineering. 30 Jun 1989. 56p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC03-76SF00700. Order Number DE89016805/JAW. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

As a first step to understanding the fundamental physical phenomena occurring during natural circulation removal of decay heat in LMFBRs, the code FLOW3D, obtained from the UKAEA, was used to conduct 2-D direct numerical simulations of one of the test runs conducted on the scaled liquid sodium reactor at ETEC. Results and analysis of the simulations are presented. Results indicate that the code captures the physics of the simulated problem. The code is highly optimized and requires about 10 μ-seconds per mesh-cell time-step on a CRAY-XMP. 3 refs., 42 figs.

47101 (PNL-SA-17011) **Nuclear closed-cycle gaseous heat engine concept.** Ross, B.A.; Drost, M.K. Pacific Northwest Lab., Richland, WA (USA). May 1989. 6p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. (CONF-890815--25: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989). Order Number DE89016824/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

A nuclear closed-cycle gaseous heat engine concept is presented in which mechanical or electrical power is produced from the fission of uranium hexafluoride (UF_6). The engine consists of a reaction chamber and piston, a regenerator, a cooler, and an expansion/compression cylinder and piston. The concept is envisioned to be useful for applications where heat sources (fossil fuel) are not easily obtained, such as for remote terrestrial or space power generation. Potential advantages include simplicity, easily transportable fuel, and reliability. The major unresolved issues include corrosion, nuclear/thermodynamic interactions, and the relatively low operating speed of the engine. 7 refs., 1 fig.

2106 Power Reactors, Auxiliary, Mobile, Package, and Transportable

Refer also to citation(s) 47351, 47752

47102 (JAERI-M-89-019) **Concept design of Advanced Marine Reactor (1), core design. Design study for optimized core.** Ambo, Noriaki; Yokomura, Takeyoshi. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1989. 47p. (In Japanese). Order Number DE90701783/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

We started the design study of the concept design of the Advanced Marine Reactor from FY 1987, and we researched and studied as for the optimization of the core and the components of the 100 MWt reactor plant that main research thema was minituarization and high performance in FY 1987. This report describes as for the core design result until today. We studied various surveyence of cores such as high average core power density (80~100 kW/l) core, high average burnup (40,000~50,000 MWd/t) core and long core life (8 years, or 4 years) core. According to the core surveyence results, we were able to construct of the optimized core in the following design condition as that its average power density was 90 kW/l, its average core burnup was about 50,000 MWd/t, its core life was 4 years, without chemical (boron) reactivity control, its Vm/Vp rate was abt 3.0 and its core height was 100 cm. (author).

2107 Regulation and Licensing

Refer also to citation(s) 47148

2108 Economics

47103 (ORNL/Sub-88-SC557/1) **Analysis of the role of regulation in the escalation of capital additions costs for nuclear power plants.** Oak Ridge National Lab., TN (USA); SC and A, Inc., McLean, VA (USA). Jul 1989. 31p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC05-84OR21400. Order Number DE89015661/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This study examines the role of regulation in the escalation of capital additions costs for nuclear power plants over the past ten years. Unlike previous studies which used a statistical approach to examine the influence of causal factors on the variation in costs, this report is based on actual case studies at four nuclear power plants operated by two utilities. These plants, which are not identified by name, span the entire range of reactor manufacturers. In addition to the evaluation of the role of regulation on capital additions costs, we also examined the contribution of requirements resulting from the accident at Three Mile Island, and where possible, the reasons for utility-initiated backfits. 3 figs., 10 tabs.

22 NUCLEAR REACTOR TECHNOLOGY

2201 Theory and Calculation

Refer also to citation(s) 47113

47104 (JAERI-M-89-030) **Vectorization of nuclear codes 88-1. SRAC, CITATION, TWOTRAN-II, COREBN, CITATION-FBR.** Nonomiya, Iwao; Harada, Hiroo. Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1989. 119p. (In Japanese). Order Number DE90701752/JAW. Available from NTIS (US Sales Only), PC A06/MF A01.

In this report, we describe the vectorization of thermal reactor standard neutronics code system SRAC, three dimensional neutron diffusion code CITATION, two dimensional discrete ordinates transport code TWOTRAN-II, multi-dimensional core burn-up calculation code COREBN, two and three dimensional neutron diffusion code CITATION-FBR. CITATION code, TWOTRAN code, collision probability method code PIJ in SRAC system are also vectorized. The performance ratio of the vectorized version to the original one is from 1.8 to 8.6 for SRC, from 2.3 to 10.1 for CITATION, 4.2 for TWOTRAN-II, from 2.9 to 10.4 for COREBN, from 3.9 to 13.3 for CITATION-FBR. In this report, we describe sample input data, summary of the codes, vectorization techniques and performance evaluation of the vectorized codes. (author).

47105 (NUREG/CR-5338) **Analysis of the VENUS-3 experiments.** Maerker, R.E. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Oak Ridge National Lab., TN (USA). Aug 1989. 75p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. (ORNL/TM-11106). Available from NTIS, PC A04/MF A01 - GPO; OSTI; INIS.

The results of applying a hybrid superposition-synthesis calculational method to a mockup of a three-dimensional geometry involving a partial length shield assembly (PLSA) at the VENUS-3 facility in Mol, Belgium, are described. Comparisons of transport calculations using the method and many measurements involving nickel, indium, and aluminum dosimeters indicate agreement generally to within five percent if effects of inaccuracies in the dosimeter cross sections are minimized and proper orientation of the coordinate system used in the synthesis procedure is observed. These conclusions bode well for the success of this method in solving neutron transport problems involving the use of PLSAs in light water reactors to reduce core leakage in pressurized thermal shock programs. A second report describing the experimental details of the measurements will serve as companion documentation to this one and will be furnished by the Studiecentrum voor Kernenergie/Centre d'Etude de l'Energie Nucleaire, Mol, Belgium. 12 refs., 4 figs., 22 tabs.

2202 Components and Accessories

Refer also to citation(s) 47147

47106 (JAERI-M-89-044) **Data book of the component failure rate stored in the RECORD.** Oikawa, Testukuni; Sasaki, Shinobu; Hikawa, Michihiro; Higuchi, Suminori. Japan Atomic Energy Research Inst., Tokyo (Japan). Apr 1989. 350p. (In Japanese). Order Number DE90701709/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

The Japan Atomic Energy Research Insitute (JAERI) has developed a computerized component reliability data base and its retrieval system, RECORD, on collected failure rates from published literatures in order to promote convenience and efficiency of systems reliability analysis in the PSA (Probabilistic Safety Assessment). In order to represent collected failure rates in a uniform format, codes are defined for component category, failure mode, data source, unit of failure rate and statistocal parameter. Up to now, approximately 11,500 pieces of component failure rate data from about 35 open literatures have been stored in the RECORD. This report provides the failure rate stored in the RECORD data base for the usage by systems analysts, as well as brief descriptions about the data base structure and how to use this data book. (author).

47107 (ORNL/FTR–2907) **[Discussion of fracture mechanics and testing for reactor pressure components, Stuttgart, W. Germany, May 23–27, 1988]: Foreign trip report.** Pugh, C.E.; Kramer, G.S. Oak Ridge National Lab., TN (USA). 23 Jun 1988. 35p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. Order Number DE89017295/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The travelers attended the two subject meetings as the US representatives. The CSNI Fracture Assessment Group is undertaking the compilation of fracture experiments that have been performed on a sufficiently large scale to permit assessment of elastic and inelastic fracture mechanics models. A few benchmark experiments will be chosen for an international comparative analysis effort. The NRC-sponsored Pressurized-Thermal-Shock Experiment, PTSE-2, will probably be chosen as the first benchmark experiment. Seventy representatives from seventeen countries attended the IAEA Specialists' Meeting on Fracture Mechanics Verification by Large Scale Testing. This meeting was sponsored by the IAEA Working Group on Reliability of Reactor Pressure Components (RRPC). The travelers presented three papers covering large-scale fracture testing of plates, vessels, and piping. A total of thirty-one presentations were made, and the travelers have copies of twenty-five of these papers in their offices at ORNL and BCD. 2 refs.

47108 (REG/G–1.84-Rev.26) **Design and fabrication Code Case acceptability, ASME Section 3, Division 1.** Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research. Jul 1989. 15p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

Section 50.55a, "Codes and Standards," of 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities", requires, in part, that components of the reactor coolant pressure boundary be designed, fabricated, and erected, and tested in accordance with the requirements for Class 1 components of Section III, "Nuclear Power Plant Components,"of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code or equivalent quality standards. This regulatory guide lists those Section III ASME Code Cases oriented to design and fabrication that are generally acceptable to the NRC staff for implementation in the licensing of light-water-cooled nuclear power plants.

2203 Fuel Elements

Refer also to citation(s) 47117, 47477

47109 (JAERI-M–89-039) **Nuclear criticality of fuel assembly having infinite multiplication factor less than unity.** Ogino, Teruhisa; Naito, Yoshitaka. Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1989. 31p. (In Japanese). Order Number DE90701699/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

A case study has been made to investigate nuclear criticality could be achieved by locating light-water reflectors surrounding a fuel assembly of which neutron infinite multiplication factor k_{∞} is less than unity. Nuclear criticality calculations were carried out for slab fuel assemblies consist of uranium dioxide (UO_2) changing enrichment of ^{235}U, density of UO_2 and H/U atomic ratios respectively in case of light-water and heavy-water reflections. A neutron spectrum factor (SF) is considered to solve the problem as a key to represent softening effect of neutron energy spectrum in the fuel assembly due to neutron reflections by the reflectors. As a result, it is found that uranium and plutonium fuels of which infinite multiplication factor, k_{∞}, are less than unity can not reach criticality condition even if they are surrounded by light-water reflectors. (author).

2204 Control Systems

Refer also to citation(s) 47121

47110 (CONF-8711245–2) **Design criteria and realization of a computerized supervisory system for nuclear applications.** Maestri, F.; Mangiarotti, M.; Maciocco, G. Ansaldo S.p.A., Genoa (Italy). Nov 1987. 22p. From Workshop on computers applications for nuclear powers and industrial process plant operation and control; Rome (Italy); 19-20 Nov 1987. Available from ENEA, Viale Regina Margherita, 125 Roma, Italy.

Paper presented at ENEA-Halden reactor project workshop on computer applications for nuclear power and industrial process plant operation and control (Rome, 19-20 Nov 1987).

This paper describes the design criteria and the realization modalities of a computerized supervisory system for nuclear applications. The man-machine interface design aspects for the Alto Lazio Nuclear Power Plant control room are discussed.

47111 (ENEA-RT-TIB–88-3) **Mathematical model for real-time diagnostics of TRIGA RC-1 system.** Gadomski, A.M.; Nanni, V.; Meo, G. ENEA, Rome (Italy). Apr 1988. V Order Number DE88755372/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

This paper presents a mathematical model for the TRIGA RC-1 reactor system. The model is dedicated to real-time early fault detection during reactor operation in a one week exploitation cycle. The algorithms are specially suited for real-time, long-time and also accelerated simulations, with assumed diagnostic oriented accuracy. The approximations, modular structure, numerical methods and validation are discussed. The elaborated model will be built in the TRIGA Supervisory System and TRIGA Diagnostic Simulator.

47112 (PINSTECH–112) **Development of on-line reactivity meter for PARR.** Ansari, S.A. Pakistan Inst. of Nuclear Science and Technology, Islamabad (Pakistan). Nuclear Engineering Div. Jun 1988. 32p. Order Number DE90601632/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

An on-line digital reactivity meter has been developed for PARR for continuous monitoring of system reactivity. The reactivity meter has a prompt response to any change in system reactivity and gives the reactivity worth of fuel or sample loading in the reactor directly in terms of % delta k/k. The reactivity meter comprises of two main parts. The first part is the hardware and software for on-line acquisition of standard in-plant neutron flux signals, while the second part is high level, Fortran-77, real-time programming for the computation of reactivity by simultaneous solution of neutron kinetic equations. The plant computer PDP-1123 Plus is used for this purpose on time sharing basis with its regular data logging function. This report describes the reactivity meter results for the determination of sample worth, control rod calibration and power coefficient of reactivity. The rod calibration results are compared with those obtained by positive period method currently employed in the reactor. Reactivity characteristics of the reactor auto-controller is also discussed. (author). 8 fig.

47113 (WHC-SP–0205) **Physics support analyses for full central-zone flux flattening for full-power (3000- to 4000-MW) operation.** Tollefson, D.A.; Finfrock, S.H.; Schwinkendorf, K.N.; Erickson, D.G.; Mohr, C.L. Westinghouse Hanford Co., Richland, WA (USA). Feb 1988. 85p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE89015993/JAW. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

New neutronics analyses have been completed to provide the bases for new neutronics and thermal hydraulics related operating limits and limits correction factors. These new analyses incorporate the effects of flux and power profile changes in the N Reactor from the introduction of the Flux Flattening Program fuel charge designs and loading patterns. While the thermal hydraulics analyses are being documented separately (References 1 and 2), all neutronics calculations and a description of the methodologies for neutronics operating limits determination are included in this document. Both unflattened and full central zone flattened cases were evaluated with new and upgraded codes and methods. Most of the neutronics and thermal hydraulics operating limits changes are very small or insignificant when comparing the flux flattened core design to the unflattened core design. The largest changes between the new and the previous limits are all due to the use of improved computer codes and analysis which allow better simulation of operating conditions. 53 refs., 33 figs., 14 tabs.

2205 Environmental Aspects

Refer also to citation(s) 47158, 47988, 47991

47114 (GA-A–19823) **Safety aspects of the Modular High-Temperature Gas-Cooled Reactor (MHTGR).** Silady, F.A.; Millunzi, A.C. General Atomics, San Diego, CA (USA). Aug 1989. 19p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC03-89SF17885. (CONF-890841–1: International workshop on safety of nuclear installations of the next generation and beyond, Chicago, IL (USA), 28-31 Aug 1989). Order Number DE89017241/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Modular High-Temperature Gas-Cooled Reactor (MHTGR) is an advanced reactor concept under development through a cooperative program involving the US Government, the nuclear industry and the utilities. The design utilizes the basic high-temperature gas-cooled reactor (HTGR) features of ceramic fuel, helium coolant, and a graphite moderator. The qualitative top-level safety requirement is that the plant's operation not disturb the normal day-to-day activities of the public. The MHTGR safety response to events challenging the functions relied on to retain radionuclides within the coated fuel particles has been evaluated. A broad range of challenges to core heat removal have been examined which include a loss of helium pressure and a simultaneous loss of forced cooling of the core. The challenges to control of heat generation have considered not only the failure to insert the reactivity control systems, but the withdrawal of control rods. Finally, challenges to control chemical attack of the ceramic coated fuel have been considered, including catastrophic failure of the steam generator allowing water ingress or of the pressure vessels allowing air ingress. The plant's response to these extreme challenges is not dependent on operator action and the events considered encompass conceivable operator errors. In the same vein, reliance on radionuclide retention within the full particle and on passive features to perform a few key functions to maintain the fuel within acceptable conditions also reduced susceptibility to external events, site-specific events, and to acts of sabotage and terrorism. 4 refs., 14 figs., 1 tab.

47115 (ORNL/FTR–2926) **[Nuclear reactor severe accident chemistry]: Foreign trip report, June 1–9, 1988.** Kress, T.S. Oak Ridge National Lab., TN (USA). 14 Jun 1988. 14p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. Order Number DE89017296/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The OECD/NEA Workshop served to update the status and progress in severe-accident-related iodine chemistry work being conducted by a number of researchers in 10 different countries. The ACS symposium covered a broad range of chemistry issues associated with severe accidents and served as one of the few opportunities for those of us working in the field of severe accidents to interact directly with outside chemical specialists. The private meeting on the ACE Program served to define a large-scale iodine behavior test program and the possible supporting laboratory roles. The results will be presented as a proposal at a mid-July meeting of the Technical Advisory Committee for the program.

47116 (ORNL/RSIC–52) **Neutron streaming benchmark calculations.** Lee, T.Y.; Cramer, S.N. Oak Ridge National Lab., TN (USA). Radiation Shielding Information Center. Aug 1989. 99p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE89015664/JAW. Available from NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.

Computational techniques used to analyze neutron streaming through cavities and ducts are described. The configurations are simplified geometries of streaming paths which can be found in nuclear fission and fusion reactors. The results obtained using available computational tools are compared to each other.

47117 (PINSTECH–111) **Preliminary radiological consequence estimate for a reference LEU core for PARR.** Younus, M.; Khan, L.A.; Akhtar, K.M.; Pervez, S. Pakistan Inst. of Nuclear Science and Technology, Islamabad (Pakistan). Reactor Operations Div. Jul 1988. 35p. Order Number DE90601704/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Radiological consequence analysis of a reference LEU core for Pakistan Research Reactor (PARR) has been carried out using mathematical models. Three modes of leakage from reactor building have been considered. These are exhaust through the normal ventilation system, through emergency ventilation system and leakage from the building. The whole body and thyroid does have been calculated for the duration of 2 hours and 30 days at the boundaries of exclusion zone at 450m and low population zone at 100m. For the releases at stack height through normal and emergency ventilation systems, does at both the boundaries remain within relevant emergency does limits of 300 rem for thyroid and 25 rem for whole body. However, in case of direct release from the containment building, limiting thyroid does of 300 rem, at 1000m, for 30 days exposure is achieved for a leak rate of 27% per day under Pasquill condition E. The results presented in this report are only preliminary estimates. A more accurate detailed analysis, for various burnups, will be carried using standard computer codes. (orig./A.B). 4 fig.

2206 Research, Test, and Experimental Reactors

Refer also to citation(s) 47105, 47112, 47117, 47141, 47199, 48304, 48493

47118 (JAERI-M–89-043) **In-pile loop OWL-2 and irradiation tests done with it.** Ikeshima, Yoshiaki; Kawano, Masakatsu; Watanabe, Hiroyuki; Suzuki, Shinobu; Sato, Hitoshi; Tanaka, Isao. Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1989. 38p. (In Japanese). Order Number DE90701700/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

The OWL-2 which was built in the JMTR as the biggest water loop in Japan has been operating for irradiation service since February 1972. The desired objective of the OWL-2, contributing to the development of various nuclear fuels and materials for the light water power reactor and to reactor engineering, has been so fully achieved that the OWL-2 in planned to be dismantled. After the dismantling, a loop, needed for the improvement of the light water reactor as a part of the JMTR capability improvement program and for the research and development of fusion reactors, is going to be installed in place of the OWL-2 in the JMTR. This paper deals with the history of the OWL-2 with an emphasis on the technical affairs taken into consideration when designing the OWL-2, the irradiation tests, development of the trubine flow meters, results of the surveillance test of the material of the in-reactor tube, the knowledge gained in the course of the investigation into the cause of TGSCC which developed in the wall of the in-reactor tube, and the countermeasures taken to prevent TGSCC from recurring. (author).

47119 (ORNL/TM–11033) **Component and system simulation models for High Flux Isotope Reactor.** Sozer, A. Oak Ridge National Lab., TN (USA). Aug 1989. 44p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89015655/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Component models for the High Flux Isotope Reactor (HFIR) have been developed. The models are HFIR core, heat exchangers, pressurizer pumps, circulation pumps, letdown valves, primary head tank, generic transport delay (pipes), system pressure, loop pressure-flow balance, and decay heat. The models were written in FORTRAN and can be run on different computers, including IBM PCs, as they do not use any specific simulation languages such as ACSL or CSMP. 14 refs., 13 figs.

47120 (PINSTECH–110) **Neutronic analysis of a reference LEU core for Pakistan research reactor using oxide fuel.** Akhtar, K.M.; Qazi, M.K.; Bokhari, I.H.; Khan, L.A.; Pervez, S. Pakistan Inst. of Nuclear Science and Technology, Islamabad (Pakistan). Reactor Operations Div. Jul 1988. 39p. Order Number DE90601679/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Neutronic analysis of a 10 MW reference core for PARR, having 28 fresh LEU fuel elements arranged in a 6x5 configuration has been carried out using standard computer codes WIMS-D, EXTERMINATOR-II, and CITATION. Total nuclear power peaking of 3.2 has bee found to occur in the fuel plate adjacent to the water filled central flux trap at the depth of 43.8 cm from the top of the active core. Replacement of water in central flux trap with an aluminum block, having a 50 mm diameter water filled irradiation

channel changes the flux profiles in fuel, core side flux trap and reflector. The thermal flux in the central flux trap decreases by about 53%. Therefore some of the fuel elements will have to be removed and the new configuration has to be analysed to determine the first operating core. However, after achieving some burn-up and confirmation from thermal hydraulic analysis, the core configuration analysed, will be the final working core. (orig./A.B.). 12 fig.

47121 (PINSTECH–113) **On-line testing of PARR instrumentation by plant computer.** Ansari, S.A. Pakistan Inst. of Nuclear Science and Technology, Islamabad (Pakistan). Nuclear Engineering Div. Oct 1988. 33p. Order Number DE90601680/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

This report describes the utilization of PARR plant computer for automatic periodic testing of nuclear instrumentation in the acquisition and processing of nuclear channel signals. Based on statistical analysis the performance characteristics like mean value, standard deviation and probability distributions of nuclear channel signals are obtained in real time. The computed errors of the channel output are compared with the standard nuclear detection errors and the computer generates a message in case the error exceeds the maximum permissible error by a fixed margin. In this way the faulty channel is automatically identified at an earlier stage, which facilitates instrument maintenance scheduling. The on-line testing program is particularly advantageous for the performance evaluation of those channels whose output signal is either not recorded on the console or which are used to generate reactor trips alone. (author). 8 fig.

2207 Plutonium and Isotope Production Reactors

Refer also to citation(s) 47111, 47113, 47135, 47166, 48701

47122 (DPST–88-1004) **Flat plate heat exchangers for the new production reactor.** Ondrejcin, R.S. Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab. 7 Dec 1988. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-76SR00001. Order Number DE89017844/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The New Production Reactor (NPR) will require heat exchangers (HX) as part of the ancillary equipment. The most common type of heat exchanger in the US is the shell and tube, the type presently in SRP reactor service. This type of design is the one that is normally described in detail in heat transfer texts. Other designs are more efficient, and there was a period when these designs were actively modified. The largest driving force for higher efficiency HX was the OPEC produced energy shortage of the early 1970's. Several comments were made by B.S. Spangler about flat plate HX for the NPR after my initial comparison between shell and tube and flat plate HX (DPST-88-729). Since answers were not readily available, Philippe Marchal of Packinox (Louveciennes, France) agreed to visit SRL. This report contains a series of answers to all comments raised in DPST-88-743 and some general statements comparing flat plate HX to shell and tube HX. 1 fig., 2 tabs.

47123 (IWGFPT–31, pp. 29-31) **Heavy isotope method for burnup determination of HFETR fuel elements.** Liao Zumin (Southwest Center for Reactor Engineering Research and Design, Chengdu (China)). International Atomic Energy Agency, Vienna (Austria). International Working Group on Water Reactor Fuel Performance and Technology. May 1989. (CONF-8806392–: IAEA technical committee meeting on burnup determination of water reactor fuel, Karlsruhe (Germany, F.R.), 13-16 Jun 1988). In *Burnup determination of water reactor fuel. Proceedings of a technical committee meeting held in Karlsruhe, 13-16 June 1988.* Order Number DE90601639/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

In this paper, a set of formulae for burnup determination of fuel element of HFETR is deduced and found. The highest burnup level of U-235 is 60% and the uncertainty of burnup values got by the set of formulae is 3%. (author). 5 refs, 2 figs, 3 tabs.

47124 (WHC-SP–0084) **Xenon transient simulation for N Reactor.** Albrecht, R.W.; McCormick, N.J.; Finfrock, S.H.; Lan, J.S.; Wu, R.M. Westinghouse Hanford Co., Richland, WA (USA). May 1988. 132p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC06-87RL10930. Order Number DE89015992/JAW. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

The stability of the spatial power distribution of N Reactor is of significance to the satisfactory operation of the reactor. The principal contributor to any potential instability in the spatial power distribution is the fluctuation in power shape that can, in principle, be induced by the fluctuation of the concentrations of Xe-135 and I-135. The potential to induce these power distribution fluctuations is influenced mainly by the reactor size, power level, power distribution, thermal hydraulic feedback, and initial perturbation conditions. This report describes the analysis of N Reactor stability for the nominal and flux flattened loadings. The response of N Reactor to variations in reactor parameters about nominal values is included to demonstrate the operation of the calculational model and the sensitivity to parametric variations. The main body of the report discusses the best estimate of xenon-induced power variations computed with the code for the case of and N Reactor with no control rod motion. Procedures to incorporate an algorithm that includes control rod motions are also discussed. 3 refs., 6 figs.

2209 Reactor Safety

Refer also to citation(s) 47084, 47099, 47114, 47116, 47731, 47960, 47992, 48123, 48124

47125 (CEA-TR–2326) **Radiological effects of Chernobyl reactor accident on the lakes of Southern Bavaria.** Laschka, D.; Hermann, H.; Huebel, K.; Luensmann, W. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Mar 1988. 12p. (In French). Order Number DE90701453/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

In order to detect the radiological effects of the Chernobyl reactor accident to the large lakes of Southern Bavaria and to assess the radiation exposure of man on the different aquatic pathways, the radioactive contamination of the surface water, the sediments and the fishes was investigated. The dependence of time of the activity concentrations in the tested medias is shown and an outlook is made on the expected further evolution. The radiation exposure of man by swimming, boating and fish consumption in the fast year after the reactor accident is calculated.

47126 (CEA-TR–2327) **Modelling of radioactive fallout in the vicinity of Chernobyl nuclear power plant accident.** Israel, Y.A.; Petrov, V.N.; Severov, D.A. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Mar 1988. 14p. (In French). Order Number DE90701454/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

Deposition of radioactive products escaping into the atmosphere for a long time from the Chernobylsk-4 reactor resulting in residual radioactive contamination of the region at a distance of up to 100 km from the nuclear power plant is considered. The suggested model may be used for estimation of the possible scope of nuclear danger in the regions of nuclear power plants and creation of conditions ensuring safety of the population at possible accidents. The following topics are developed: height of elevation and conditions of radionuclide transfer in the atmosphere; dynamics of release and dispersive composition of radioactive products; calculations of radiation levels at a close trace.

47127 (CEA-TR–2336) **Environmental radioactivity and water supply. Pt. 3. The contamination of surface waters in Germany after the Chernobyl reactor accident.** Haberer, K. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Mar 1988. 10p. (In French). Order Number DE90701456/JAW. Available from NTIS (US Sales Only), PC A02/MF A01.

After the reactor accident, german surface waters have been monitored in numerous positions over a long period of time. The highest concentrations of iodine 131 occurred in the lower german region of the Danube river with more than 200 Bq/l whereas the Rhine river had the lowest concentrations. The sudden rise of the radioactivity of the river water have been followed by a slower decrease but nevertheless much faster than the radioactive decay. Probably this is caused by the interaction with river sediments. For the german lakes and reservoirs it was very important whether the water masses have been stratified or not when the radioactive

cloud arrived. Where this was the case, the radioactive contaminants remained predominantly in the upper layer, the epilimnion for a long period of time.

47128 (CEA-TR–2367) **Radiological consequences of the Chernobyl accident in the Soviet union and measures taken to mitigate their impact.** Ilin, L.A.; Pavlovsky, O.A. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Oct 1987. 35p. (In French). Order Number DE90701459/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

On the basis of factual material on the levels of radioactive contamination of the environment in various regions of the Soviet Union, a forecast is given of the radiological consequences of the Chernobyl accident for the Soviet population.

47129 (CEA-TR–2468) **Thyroid dose from ^{131} iodine of the population in Poland following the Chernobyl accident.** Krzesniak, J.W. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Nov 1987. 24p. (In French). Order Number DE90701455/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

The following studies were carried out in the period from 28 April to 20 June 1986 in the Central Laboratory of radiological Protection (C.L.O.R.) in Poland: atmosphere monitoring in the period from 28 April to 22 May evaluating ^{131} I environmental concentration with the percentage of iodine in elementary, aerosol and organic compound form; determination of thyroid dose in 1049 persons from mine regions in Poland.

47130 (CEA-TR–2469) **Environmental impacts of Chernobyl reactor accident in German Democratic Republic.** CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Oct 1987. 49p. (In French). Order Number DE90701452/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

The radiation monitoring results published in this SAAS report correspond with the introductory paper to the compilation of data measured in the German Democratic Republic in the period May to September 1986, which was submitted to the IAEA in October 1986. The conclusion to be drawn from these results is that it was at no time necessary to restrict food consumption or to change nutritional habits in order to avoid detrimental health effects.

47131 (CONF-890721–39) **Evaluation of LMR [liquid metal reactors] core support concepts under seismic events.** Wu, Ting-shu; Seidensticker, R.W. Argonne National Lab., IL (USA). 1989. 4p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From Joint ASME/JSME pressure vessel and piping conference; Honolulu, HI (USA); 23-27 Jul 1989. Order Number DE89016902/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

In the design of the core support system for liquid metal reactors (LMR) against earthquakes, the major concerns are directed toward the structural integrity as well as the reactivity control. This means that, in addition to the stress levels, maximum displacements and accelerations should also be within their allowable limits. This investigation studies the seismic responses of a large pool-type LMR with different design approaches to support the reactor core. Different core support designs yield different frequency ranges and responses. Responses of these designs to the given floor response spectra are required to satisfy a set of criteria which are common to all designs. 5 refs., 4 figs.

47132 (CONF-890721–40) **Seismic analysis of a large pool-type LMR [liquid metal reactor].** Wang, C.Y.; Gvildys, J. Argonne National Lab., IL (USA). 1989. 11p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From Joint ASME/JSME pressure vessel and piping conference; Honolulu, HI (USA); 23-27 Jul 1989. Order Number DE89016903/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper describes the seismic study of a 450-MWe liquid metal reactor (LMR) under 0.3-g SSE ground excitation. Two calculations were performed using the new design configuration. They deal with the seismic response of the reactor vessel, the guard vessel and support skirt, respectively. In both calculations, the stress and displacement fields at important locations of those components are investigated. Assessments are also made on the elastic and inelastic structural capabilities for other beyond-design basis seismic loads. Results of the reactor vessel analysis reveal that the maximum equivalent stress is only about half of the material yield stress. For the guard vessel and support skirt, the stress level is very small. Regarding the analysis if inelastic structural capability, solutions of the Newmark-Hall ductility modification method show that the reactor vessel can withstand seismics with ground ZPAs ranging from 1.015 to 1.31 g, which corresponds to 3.37 to 4.37 times the basic 0.3-g SSE. Thus, the reactor vessel and guard vessel are strong enough to resist seismic loads. 4 refs., 10 figs., 5 tabs.

47133 (CONF-890741–2) **Seismic analysis of the EBR-II [Experimental Breeder Reactor-II] containment structure.** Gale, J.G.; Lehto, W.K. Argonne National Lab., Idaho Falls, ID (USA). 1989. 16p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract W-31109-ENG-38. From ASME international computers in engineering conference; Anaheim, CA (USA); 30 Jul - 2 aug 1989. Order Number DE89016911/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Experimental Breeder Reactor-II (EBR-II) is a liquid metal reactor located at the Argonne National Laboratory near Idaho Falls, Idaho. At the time the EBR-II was designed and constructed, there were no engineering society or federal guidelines specifically directed toward the seismic design of reactor containment structures; hence static analysis techniques were used in the design. With the increased focus on safety of reactor and fuel reprocessing facilities. Argonne has initiated a program of analyzing its existing facilities for seismic integrity using current Department of Energy Guidelines and industry concensus standards. A seismic analysis of the EBR-II containment building has been performed using finite element analysis techniques. The containment building is essentially a vertical right cylindrical steel shell with heads on both ends. The structure is unique in that the interior of the shell is lined with reinforced concrete. The actual containment function of the building is served by the steel shell; whereas the function of the concrete liner is to serve as a missile shield and a thermal insulating shield to protect the steel containment shell from internally generated missiles and fires. Model development and structural evaluation of the EBR-II containment building are discussed in this paper. 6 refs., 8 figs.

47134 (DOE/SSDP–0074) **Preparation, lifting and loading of the Shippingport Reactor Pressure Vessel/Neutron Shield Tank Package.** Yannitell, D.M. General Electric Co., Shippingport, PA (USA). Nuclear Energy Business Operations. [1989]. 17p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-87RL10930;AC06-84RL10421. (CONF-890604–16: Annual meeting of the American Nuclear Society, Atlanta, GA (USA), 4-8 Jun 1989). Order Number DE89016834/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

In 1985, following end-of-life testing and defueling, the Shippingport Station Decommissioning Project (SSDP) commenced physical decommissioning to demonstrate that the final stage of a nuclear plant lifecycle, decommissioning, can be performed both safely and cost effectively. The shipment of the shielded irradiated Reactor Pressure Vessel/Neutron Shield Tank (RPV/NST) Package from Shippingport, PA to Richland, WA by barge as a single package was the largest non-military radioactive shipment ever made. This paper discusses the basis for the one-piece removal option, describes how the RPV/NST was prepared to comply with government regulations for shipping radioactive material, and the methods utilized to lift the RPV/NST and load it onto a barge for its subsequent shipment to Richland, WA.

47135 (EGG-EAST–8382) **RELAP5/MOD2.5 thermal hydraulic analysis for an alternate fuel desig in the N Reactor.** Bolander, M.A. EG and G Idaho, Inc., Idaho Falls, ID (USA). Jun 1989. 67p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. Order Number DE89016192/JAW. Available from NTIS, PC E04/MF E05 - OSTI; GPO Dep.

Includes 2 sheets of 24x reduction microfiche.

This report documents work performed at the Idaho National Engineering Laboratory (INEL) in support of the Westinghouse Hanford Company safety analyses of the N Reactor. This work included: (1) developing a RELAP5/MOD2.5 N Reactor separate effects alternate fuel design model, (2) performing a RELAP5/MOD2.5 computer

code validation for N Reactor applications, (3) performing a radiation heat transfer sensitivity study to observe the effects of radiation heat transfer for a design-basis accident, and (4) performing and analyzing RELAP5/MOD2.5 scoping calculations using the alternate fuel design model for a design-basis accident. 11 refs., 19 figs., 4 tabs.

47136 (EGG-M–89091) **Investigation of reactor coolant system depressurization as an accident management strategy.** Golden, D.W.; Odar, F.; Miller, J.D. EG and G Idaho, Inc., Idaho Falls, ID (USA). 1989. 29p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC07-76ID01570. (CONF-8906181–2: International Thermonuclear Experimental Reactor (ITER) specialist meeting on electromagnetics, Garching (Germany, F.R.), 22 Jun 1989). Order Number DE89016207/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An investigation of intentional depressurization of the reactor coolant system (RCS) as a means to mitigate direct containment heating (DCH) is presented in this paper. Primary and secondary feed-and-bleed strategies are considered as basic options to prevent core damage. For a station blackout, where the ac power is lost, there is no safety injection. For a TMLB′ transient, the additional failure of the auxiliary feedwater is assumed. For this transient, a primary or secondary feed-and-bleed strategy using existing systems is not possible because of unavailability of the safety injection and auxiliary feedwater. The operators can take action to depressurize the primary system using the pressurizer power-operated relief valves (PORV), take no action, or find an emergency source of water independent of ac power to perform a feed-and-bleed operation. The last option may require some minor plant system modifications. Analyses for depressurization of the Surry Nuclear Power Plant are being performed using the SCDAP/RELAP5 code for a hypothetical TMLB′ sequence. Two cases with different times for the initiation of depressurization are considered. In the first case, the depressurization is initiated at the time of steam generator dry out. This case is called early depressurization. In the second case, the depressurization is initiated at the time of core uncovery. This case is called late depressurization. Both calculations show that the system can be depressurized to the level that DCH may be minimized. In the early depressurization, the surge line may also fail, leading to rapid depressurization of the primary. In the late depressurization, surge line failure is not predicted. 23 refs., 11 figs., 3 tabs.

47137 (EPRI-NP–6180) **Matrix database of EPRI experimental projects on small-break loss-of-coolant accidents: Final report.** House, R.K. Electric Power Research Inst., Palo Alto, CA (USA); Intermountain Technologies, Inc., Idaho Falls, ID (USA). c Aug 1989. 123p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

The large break LOCA had been studied extensively for many years and substantial analytical methods had been developed and verified for evaluation of this DBA. The nature of the physical processes which occur during a SBLOCA are significantly different than those which occur in a DBA LOCA, especially for a pressurized water reactor (PWR). As a result, only a portion of the methods developed for large break LOCA evaluation were applicable to SBLOCA, and a new list of research priorities arose out of questions raised during the evaluation of TMI-2. The nuclear safety research and development program at EPRI responded to the industry's need for improved understanding of SBLOCA. Projects to investigate SBLOCA that were in place prior to the TMI-2 accident were augmented and new projects were implemented. The overall cope of EPRI SBLOCA projects include both analytical development and experimental work. This report focuses on the experimental work sponsored by EPRI to support improved understanding of the SBLOCA. All of the EPRI experimental projects which relate to SBLOCA, both prior to and following TMI-2, were reviewed and the results summarized in an attempt to provide an overall matrix oriented view of the EPRI SBLOCA experimental database. 5 tabs.

47138 (EPRI-NP–6476) **EPRI workshop on fire protection in nuclear power plants: Final report.** Sursock, J.P. Electric Power Research Inst., Palo Alto, CA (USA). c Aug 1989. 234p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report constitutes the Proceedings of a Workshop on Fire Protection in Nuclear Power Plants organized by EPRI and cosponsored by Baltimore Gas and Electric Co. and the Edison Electric Institute. The workshop covered current issues related to Fire Protection in Nuclear Power Plants. These issues include implementation of Generic Letters on Appendix R, sealing of conduits penetrating fire barriers, effects of fire suppressants on electrical equipment, protection of grouped electrical cables, maintenance and information systems, and the emerging issue of fire risk assessment (PRAs) and identification of vulnerabilities. Two panel discussions were also held, whose transcripts are reported here, covering the issues of Fire brigade training and Fire PRAs methodologies. The workshop was particularly popular and successful in promoting interaction and exchange of ideas and information among various segments of the industry and the regulatory agencies.

47139 (GRS-F–172) **Reports on research programs in the field of reactor safety sponsored by the Federal Ministry for Research and Technology. Reported period: July 1 - December 31, 1988.** Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Koeln (Germany, F.R.). Jun 1989. 444p. (In German). Order Number DE90703171/JAW. Available from NTIS (US Sales Only), PC A19/MF A01.

Each progress report represents a compilation of individual reports about objectives, the work performed, the results, the next steps of the work etc. The individual reports are prepared in a standard form by the contractors themselves as a documentation of their progress in work and published by the FB Forschungsbetreuung (Research Coordination Department) at the GRS, within the framework of general information of progress in reactor safety research. The individual reports are classified according to the research program on the safety of LWR 1977-1980 of the BMFT. Another table of contents uses the same classification system as applied in the nuclear safety index of the CEC (Commission of the European Communities) and the OECD (Organization for Economic Cooperation and Development). The reports are arranged in the sequence of their project numbers. (orig.).

47140 (GRS-F–173) **Annual report on reactor safety research projects sponsored by the Ministry for Research and Technology of the Federal Republic of Germany 1988.** Gesellschaft fuer Reaktorsicherheit m.b.H. (GRS), Koeln (Germany, F.R.). Jun 1989. 469p. Order Number DE90702849/JAW. Available from NTIS (US Sales Only), PC A20/MF A01.

The GRS (Society for Reactor Safety), Gesellschaft fuer Reaktorsicherheit mbH, by order of the BMFT, informs continuously of the status of such investigations by means of semi-annual and annual publication of progress reports within the series GRS-F-Fortschrittsberichte (GRS-F-Progress Reports). Each progress report represents a compilation of individual reports about objectives, the work performed, the results, the next steps of the work etc. The individual reports are prepared in a standard form by the contractors themselves as a documentation of their progress in work and published by the FB (Research Coordination Department) Forschungsbetreuung at the GRS, within the framework of general information of progress in the reactor safety research. The individual reports are classified according to the same classification system as applied in the nuclear index of the CEC (Commission of the European Communities) and the OECD (Organization for Economic Cooperation and Development). The reports are arranged in sequence of their project numbers. Besides the progress reports, lists of reports exchanged under international exchange agreements by the BMFT are published within this series. (orig./HP).

47141 (INIS-mf–11535) **Annual report 1987-1988.** Australian Nuclear Science and Technology Organisation, Lucas Heights (Australia). Safety Review Committee. 1988. 36p. Order Number DE90601790/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Contains the annual report of the Nuclear Safety Bureau 1987-1988 as Appendix B.

This First Annual Report of the Safety Review Committee describes the Committee's operations for the year ending 30 June 1988. The Committee was established on 27 April 1987 in accordance with Section 26 of the Australian Nuclear Science and Technology Organisation (ANSTO) Act. The report provides an

overview of ANSTO's Lucas Heights site, its facilities and resources and the potential of its operations for off-site consequences. The safety of the HIFAR and MOATA reactors, the HIFAR refurbishing program, the management of radioactive wastes, and occupational health and safety are discussed as well as the regulatory environment in which ANSTO operates.

47142 (INIS-mf–12001) **Survey of incidents in West German nuclear power plants in the first quarter of the year 1989.** Bundesministerium fuer Umwelt, Naturschutz und Reaktorsicherheit, Bonn (Germany, F.R.). 1989. 12p. (In German). Order Number DE90702753/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

88 incidents were reported. Five incidents fall into category E (immediate notification). 83 incidents belong to the lowest category N (normal notification) and to the category V (pre-commissioning phase). There were no incidents of category S (direct notification). (orig./HP).

47143 (INIS-XN–185) **Radiation protection survey of research and development activities initiated after the Chernobyl accident. Review report.** Burkart, W. Nuclear Energy Agency, 75 - Paris (France). 1989. 74p. Order Number DE90601395/JAW. Available from NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS.

The compilation of research and development activities in the various fields of radiation protection in OECD Member countries which have been undertaken or planned specifically to address open questions arising from the Chernobyl reactor accident experience shows a potential for international cooperative arrangements and/or coordination between national programmes. Both the preliminary review of the answers, which only cover a part of the relevant activities in OECD Member countries, and a computerized literature search indicate that the multidisciplinarity of the research area under consideration will call for special efforts to efficiently implement new models and new quantitative findings from the different fields of activity to provide an improved basis for emergency management and risk assessment. Further improvements could also be achieved by efforts to initiate new activities to close gaps in the programmes under way, to enhance international cooperation, and to coordinate the evaluation of the results. This preliminary review of the answers of 17 Member countries to the questionnaire on research and development activities initiated after the Chernobyl accident is not sufficient as a basis for a balanced decision on those research areas most in need for international cooperation and coordination. It may however serve as a guide for the exploration of the potential for international cooperative arrangements and/or coordination between national programmes by the CRPPH. Even at this preliminary stage, several specific activities are proposed to the NEA/OECD by Member countries. Whole body counting and the intercomparison of national data bases on the behaviour of radionuclides in the environment did attract most calls for international cooperation sponsored by the NEA.

47144 (KFK–4477) **The WECHSL-Mod2 code: A computer program for the interaction of a core melt with concrete including the long term behavior. Model description and user's manual.** Reimann, M.; Stiefel, S. Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projektgruppe LWR-Sicherheit. Jun 1989. 161p. Order Number DE90702845/JAW. Available from NTIS (US Sales Only), PC A08/MF A01.

The WECHSL-Mod2 code is a mechanistic computer code developed for the analysis of the thermal and chemical interaction of initially molten LWR reactor materials with concrete in a two-dimensional, axisymmetrical concrete cavity. The code performs calculations from the time of initial contact of a hot molten pool over start of solidification processes until long term basemat erosion over several days with the possibility of basemat penetration. The code assumes that the metallic phases of the melt pool form a layer at the bottom overlayed by the oxide melt atop. Heat generation in the melt is by decay heat and chemical reactions from metal oxidation. Energy is lost to the melting concrete and to the upper containment by radiation or evaporation of sumpwater possibly flooding the surface of the melt. Thermodynamic and transport properties as well as criteria for heat transfer and solidification processes are internally calculated for each time step. Heat transfer is modelled taking into account the high gas flux from the decomposing concrete and the heat conduction in the crusts possibly forming in the long term at the melt/concrete interface. The WECHSL code in its present version was validated by the BETA experiments. The test samples include a typical BETA post test calculation and a WECHSL application to a reactor accident. (orig.).

47145 (KFK–4574) **Investigations of vapour explosions with alumina-droplets in sodium.** Zimmer, J. Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Reaktorentwicklung; Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projekt Schneller Brueter; Karlsruhe Univ. (T.H.) (Germany, F.R.). Fakultaet fuer Maschinenbau. Jun 1989. 154p. (In German). Order Number DE90702850/JAW. Available from NTIS (US Sales Only), PC A08/MF A01.

Within the analysis of severe hypothetical fast breeder accidents the consequence of a fuel-coolant interaction has to be considered, i.e. the thermal interaction between hot molten fuel and sodium. Experiments have been performed to study the thermal fragmentation of a molten alumina droplet in sodium. Alumina temperatures up to 3100 K and sodium temperatures up to 1143 K were used. For the first time film boiling of alumina drops in sodium was achieved. With some droplets undergoing film boiling, the fragmentation was triggered by an externally applied pressure wave. In these experiments, the trigger was followed promptly by a strong reaction pressure wave if and only if a contact temperature threshold of T_I=2060 K+-160 K was exceeded. In agreement with similar experiments in which other materials were studied, this threshold corresponds to an interfacial temperature close to the homogeneous nucleation temperature of the vapourising liquid. Based on the present and previous experimental results a model concept of thermal fragmentation is developed. (orig./HP).

47146 (NUREG–1365) **Revised Severe Accident Research Program plan, FY 1990–1992.** Nuclear Regulatory Commission, Washington, DC (USA). Div. of Systems Research. Aug 1989. 30p. Sponsored by Nuclear Regulatory Commission. Available from NTIS, PC A03/MF A01 - GPO; OSTI; INIS.

For the past 10 years, since the Three Mile Island accident, the NRC has sponsored an active research program on light-water-reactor severe accidents as part of a multi-faceted approach to reactor safety. This report describes the revised Severe Accident Research Program (SARP) and how the revisions are designed to provide confirmatory information and technical support to the NRC staff in implementing the staff's Integration Plan for Closure of Severe Accident Issues as described in SECY-88-147. The revised SARP addresses both the near-term research directed at providing a technical basis upon which decisions on important containment performance issues can be made and the long-term research needed to confirm and refine our understanding of severe accidents. In developing this plan, the staff recognized that the overall goal is to reduce the uncertainties in the source term sufficiently to enable the staff to make regulatory decisions on severe accident issues. However, the staff also recognized that for some issues it may not be practical to attempt to further reduce uncertainties, and some regulatory decisions or conclusions will have to be made with full awareness of existing uncertainties. 2 figs., 1 tab.

47147 (NUREG/CR–4234-Vol.2) **Aging and service wear of electric motor-operated valves used in engineered safety-feature systems of nuclear power plants: Aging assessments and monitoring method evaluations.** Haynes, H.D. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering; Oak Ridge National Lab., TN (USA). Aug 1989. 198p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC05-84OR21400. (ORNL–6170/V2). Available from NTIS, PC A10/MF A01 - GPO; OSTI; INIS.

Motor-operated valves (MOVs) are located in almost all plant fluid systems. Their failures have resulted in significant plant maintenance efforts. More important, the operational readiness if nuclear plant safety-related systems has often been affected by MOV degradation and failure. Thus, in recent years MOVs have received considerable attention by the Nuclear Regulatory Commission and the nuclear power industry and were identified as a component for study by the Nuclear Plant Aging Research (NPAR) Program. In support of the NPAR Program, a comprehensive Phase II aging assessment on MOVs was performed by the Oak Ridge National Laboratory (ORNL), and the results of this study are presented in

this report. An evaluation of commercially available MOV monitoring methods was carried out, as well as an assessment of other potentially useful techniques. These assessments led to the identification of an effective, nonintrusive, and remote technique, namely, motor current signature analysis (MCSA). The capabilities of monitoring methods (especially MCSA) for detecting changes in operating conditions and MOV degradation were investigated in controlled laboratory tests at ORNL, in situ MOV tests at a neighboring nuclear power plant, and the Gate Valve Flow Interruption Blowdown test in Huntsville, Alabama. 17 refs., 121 figs., 10 tabs.

47148 (NUREG/CR–5396) **Financial impact of implementing draft ANSI Standard N13.30, performance criteria for radiobioassay.** Traub, R.J.; MacLellan, J.A. Nuclear Regulatory Commission, Washington, DC (USA). Div. of Regulatory Applications; Pacific Northwest Lab., Richland, WA (USA). Jul 1989. 66p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC06-76RL01830. (PNL–6924). Available from NTIS, PC A04/MF A01 - GPO - OSTI.

In order to establish standards of bioassay performance upon which a uniform national program of performance testing might be based, the Health Physics Society Standards Committee (HPSSC) formed Working Group 2.5 to prepare the draft American National Standards Institute, Inc. (ANSI) Standard N13.30, Performance Criteria for Radiobioassay. Because the US Nuclear Regulatory Commission (NRC) is considering whether to require that all bioassay service laboratories meet the criteria of the draft Standard, the NRC staff requested that the Pacific Northwest Laboratory (PNL) estimate the costs that may be incurred in implementing the draft Standard. Two types of laboratories were involved in the cost study: service laboratories and a performance testing laboratory. Cost estimates based on responses to questionnaires sent to seven facilities performing radiobioassays varied in relation to the extent of each facility's radiobioassay program and to their perception of their readiness for accreditation. Implementation of accreditation was estimated to cost each facility between a few thousand dollars to over one-quarter million dollars depending on the facility type. Likewise, annual costs ranged from a few hundred dollars to $170,000. For all but one facility, annual costs were estimated to be less than $25,000. In addition to these costs, startup cost for the testing laboratory were estimated to be approximately $322,000. 5 refs., 22 tabs.

47149 (ORNL/FTR–2836) **[Technical Program Committee for the European Nuclear Society/American Nuclear Society meetings]: Foreign trip report, March 26–April 2, 1988.** Malinauskas, A.P. Oak Ridge National Lab., TN (USA). 11 Apr 1988. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017428/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A meeting of the Technical Program Committee for the ENS/ANS International Conference on Thermal Reactor Safety was held to develop the detailed technical organizational structure of the conference and to review and determine the disposition of over 320 papers which had been proposed for presentation. In addition, a meeting was held with staff of The Commissariat a l'Energie Atomique to discuss the French reactor safety research program.

47150 (ORNL/FTR–3130) **[Status of the PHEBUS-FR severe accident research project]: Foreign trip report, November 13–18, 1988.** Kress, T.S. Oak Ridge National Lab., TN (USA). 23 Nov 1988. 25p. Sponsored by DOE/NE;NRC. DOE Contract AC05-84OR21400. Order Number DE89017393/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This document reports on meetings held at Cadarache, 11/15–17/1988, between an NRC/RES delegation (an NRC/RES team leader and two contractor/laboratory representatives) and representatives from the proposed PHEBUS-FP Program. A list of issues/questions developed by an NRC ad hoc review group had been transmitted to the PHEBUS-FP personnel in advance of the meeting. The discussions focused on this list and on possible NRC support for the program during the first two years' planning and definition phases. Many (but not all) of the issues were satisfactorily addressed by significant changes in the proposed program. The providing of a "turn-key" installation of a laser-based aerosol monitor used in the PBF tests was identified as an area of contribution that the PHEBUS project would desire of NRC during the two year period prior to the actual tests.

47151 (SAND–89-1854C) **Uncertainties in hydrogen combustion for nuclear reactor safety.** Stamps, D.W.; Worthington, P.R.; Wong, C.C. Sandia National Labs., Albuquerque, NM (USA). 1989. 29p. Sponsored by Nuclear Regulatory Commission. DOE Contract AC04-76DP00789. (CONF-8908127–1: 3. international seminar on containment of nuclear reactors, Los Angeles, CA (USA), 10-11 Aug 1989). Order Number DE89016030/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Two important areas of hydrogen combustion with uncertainties are identified: (1) high-temperature combustion and (2) flame acceleration and deflagration-to-detonation transition (DDT). The uncertainties associated with high-temperature combustion may affect phenomena in a least four different accident scenarios: the in-cavity oxidation of combustible gases produced by core-concrete interactions, the combustion of hydrogen following high pressure melt ejection, the possibility of local detonations, and combustion in the BWR Mark I and Mark II secondary containments. The uncertainty in the area of DDT has increased importance due to recent experimental results that show that the detonability limit is nominally at or near the flammability limit for some mixture conditions. How these uncertainties may affect various accident scenarios is discussed and recommendations are made to reduce these uncertainties. 35 refs., 8 figs., 2 tabs.

47152 (SAND–89-1878C) **Steam explosion triggering and propagation: Hypotheses and evidence.** Berman, M.; Beck, D.F. Sandia National Labs., Albuquerque, NM (USA). 29 Aug 1989. 56p. Sponsored by DOD;DOE/DP. DOE Contract AC04-76DP00789. (CONF-8908127–2: 3. international seminar on containment of nuclear reactors, Los Angeles, CA (USA), 10-11 Aug 1989). Order Number DE89016765/JAW. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Various models of steam explosion triggering and propagation are reviewed. An analogy is drawn between steam explosions and chemical combustion, stressing that a continuum of steam explosion intensities can exist, ranging from very weak deflagration-like phenomena to full-scale detonation-like explosions. Evidence is presented to support several hypotheses: (1) that most, if not all, reported steam explosions were not strong steady thermal detonations; (2) that unsteady, oscillatory and partial-reaction steam explosions may exist for a wide range of fragmentation times; (3) that steam explosions may have large reaction zones (or interaction regions) of the order of several meters; (4) that fragmentation times of the order of 40–200 μs may be fast enough to sustain strong thermal detonations; (5) that explosion strength can increase dramatically with trigger strength; and (6) that the product of pressure and impulse may be good measure of trigger strength. New experimental data and calculations are presented to support some of these hypotheses. 84 refs., 19 figs., 1 tab.

47153 **Alpha survey instruments.** Olsher, R.H. (Los Alamos National Lab., P.O. Box 1663, Mail Stop K483, Los Alamos, NM (US)). vp of Proceedings of the twentyfirst midyear topical meeting of the Health Physics Society. Health Physics Society, McLean, VA (1987). (CONF-871202–: 21. mid-year topical meeting of the Health Physics Society: power reactor health physics, Bal Harbour, FL (USA), 13-17 Dec 1987).

Los Alamos National Laboratory and Pacific Northwest Laboratory tested alpha radiation survey instruments for the Department of Defense. Five models were evaluated for their ability to detect radiation, susceptibility to mechanical stress, sensitivity to radio-frequency and other environmental factors, and field performance. This paper concentrates on the field-testing phase of this evaluation, which was designed to measure the hot spot detection frequency of competing models under realistic survey conditions when used by surveyors with a broad spectrum of experience. The data were analyzed to determine alpha source activity for a 50% detection frequency. This is the source activity that is detected 50% of the time under survey conditions. The results show that none of the models tested reliably detect spot activities below about 500 disintegrations per minute

(dpm) and support the conclusion that these models are not suitable for verifying compliance with transuranic release limits of 100 or 300 dpm/100cm^2. The implications of this finding are discussed.

47154 Lessons learned from a review of post-accident sampling systems, high range effluent monitors and high concentration particulate iodine samplers. Hull, A.P. (Safety and Environmental Protection Div., Brookhaven National Lab., Upton, NY (US)); Knox, W.H.; White, J.R. vp of Proceedings of the twenty-first midyear topical meeting of the Health Physics Society. Health Physics Society, McLean, VA (1987). (CONF-871202–: 21. mid-year topical meeting of the Health Physics Society: power reactor health physics, Bal Harbour, FL (USA), 13-17 Dec 1987).

Post-accident sampling systems (PASS), high range gaseous effluent monitors and sampling systems for particulates and iodine in high concentrations which were installed to meet the requirements of NUREG-0737 have been reviewed at twenty-one licensee sites in Region I of the U.S. Nuclear Regulatory Commission which includes fifteen BWR's and fourteen PWR's. Although most of the installed PASS met the NUREG-0737 criteria, the highest operational readiness was found in on-line systems which were also used for routine sampling and analysis. The detectors used in the gaseous effluent monitors included external ion chambers, GM tubes, organic scintillators and Cd-Te solid state crystals. Although all were found acceptable, each had its own inherent limitations in the conversion of detector output to the time varying concentration of a post-accident mixture of noble gases.

47155 The impact of fuel cladding failure events on occupational radiation exposures at nuclear power plants. Moeller, M.P. (Pacific Northwest Lab., P.O. Box 999, Richland, WA (US)); Martin, G.F.; Kenoyer, J.L.; Stoetzel, G.A.; VanderMolen, H.J. vp of Proceedings of the twentyfirst midyear topical meeting of the Health Physics Society. Health Physics Society, McLean, VA (1987). (CONF-871202–: 21. mid-year topical meeting of the Health Physics Society: power reactor health physics, Bal Harbour, FL (USA), 13-17 Dec 1987).

This paper summarizes two case studies that evaluated the impact of fuel cladding failures on occupational radiation exposures at pressurized water reactors (PWRs). For the case studies, radiation measurements were made both during routine operations and during the subsequent maintenance and refueling outage ata PWR with more than 0.2% failed fuel. Gamma spectroscopy measurements, radiation exposure rate determinations, thermoluminescent dosimeter assessments, and air sample analyses were made in the plant's radwaste, pipe penetration, and containment buildings. Small highly radioactive fuel particles, which contaminated the plant's fuel handling building, were also analyzed. Based on the data collected, fuel cladding failures increased radiation exposure rates an estimated 540% in some areas of the plant during routine operations. Furthermore, the fraction of the total exposure rates due to fission products remained relatively constant over the duration of the outage.

47156 U.S. NRC emergency response dose assessment model. Sjoreen, A.L. (Oak Ridge National Lab., P.O. Box X, MS 243, Oak Ridge, TN (US)); Athey, G.F.; Sakenas, C.A.; McKenna, T.J. vp of Proceedings of the twentyfirst midyear topical meeting of the Health Physics Society. Health Physics Society, McLean, VA (1987). (CONF-871202–: 21. mid-year topical meeting of the Health Physics Society: power reactor health physics, Bal Harbour, FL (USA), 13-17 Dec 1987).

A new MS DOS-based dose assessment model has been written for the U.S. Nuclear Regulatory Commission to replace the IRDAM model for use during response to emergencies. It has been designed to be fast, very simple to use, and to be easy to modify, with separate modules of the source term, atmospheric transport, and dose models. The source term can be estimated based on isotopic ratios or on recently developed procedures which depend only on gross plant conditions. The atmospheric transport and dose models have been adapted from MESORAD. The transport model is a combination of a Lagrangian puff and Gaussian plume dispersion models. Doses are computed for whole body, lung, and thyroid for each grid location.

47157 Use of probabilistic risk assessment (PRA) in expert systems to advise nuclear plant operators and managers. Uhrig, R.E. (Instrumentation and Controls Div., Oak Ridge National Lab., P.O. Box X, Oak Ridge, TN (US)). vp of Applications of artificial intelligence VI. Trivedi, M.M. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (1988). (CONF-880464–: Applications of artificial intelligence VI, Orlando, FL (USA), 4-6 Apr 1988).

The use of expert systems in nuclear power plants to provide advice to managers, supervisors and/or operators is a concept that is rapidly gaining acceptance. Generally, expert systems rely on the expertise of human experts or knowledge that has been codified in publications, books, or regulations to provide advice under a wide variety of conditions. In this work, a probabilistic risk assessment (PRA) of a nuclear power plant performed previously is used to assess the safety status of nuclear power plants and to make recommendations to the plant personnel. Nuclear power plants have many redundant systems and can continue to operate when one or more of these systems is disabled or removed from service for maintenance or testing. PRAs provide a means of evaluating the risk to the public associated with the operation of nuclear power plants with components or systems out of service. While the choice of the source term and methodology in a PRA may influence the absolute probability and consequences of a core melt, the ratio of the PRA calculations for two configurations of the same plant, carried out on a consistent basis, can readily identify the increase in risk associated with going from one configuration to the other.

47158 Overview, what is ALARA. Baum, J.W. (Brookhaven National Lab., Safety and Environmental Protection Div., Upton, NY (US)). vp of Proceedings of the twentyfirst midyear topical meeting of the Health Physics Society. Health Physics Society, McLean, VA (1987). (CONF-871202–: 21. mid-year topical meeting of the Health Physics Society: power reactor health physics, Bal Harbour, FL (USA), 13-17 Dec 1987).

As low as reasonably achievable (ALARA) in radiation protection at nuclear power plants is a complex criterion involving decisions requiring both professional judgement and quantification. The former has been emphasized in most plants to date, however, unless quantitative studies are made it is difficult to judge if doses at U.S. plants are ALARA. An ALARA assessment for each plant is suggested, which would include evaluations of both qualitative (e.g. organizational) and quantitative (e.g. cost-benefit or cost-effectiveness) efforts.

47159 Emergency preparedness lessons from Chernobyl. Martin, J.B. (Pacific Northwest Lab., P.O. Box 999, Richland, WA (US)). vp of Proceedings of the twentyfirst midyear topical meeting of the Health Physics Society. Health Physics Society, McLean, VA (1987). (CONF-871202–: 21. mid-year topical meeting of the Health Physics Society: power reactor health physics, Bal Harbour, FL (USA), 13-17 Dec 1987).

Emergency preparedness at nuclear power plants in the U.S has been considerably enhanced since the Three Mile Island accident, The Chernobyl accident has provided valuable data that can be used to evaluate the merit of some of these enhancements and to determine the need for additional improvements, for example, the USSR intervention levels of 25 rem and 75 rem for evacuation are contrasted with U.S Environmental Protection agency protective action guides. The manner in which 135,000 persons were evacuated from the 30-km zone around Chernobyl is contrasted with typical U.S. evacuation plans. Meteorological conditions and particulate deposition patterns were studied to infer characteristics of the radioactive plume from Chernobyl. Typical plume monitoring techniques are examined in light of lessons learned by the Soviets about plume behavior. This review has indicated a need for additional improvements in utility and government emergency plans, procedures, equipment, and training.

47160 Emergency environmental monitoring practices at U.S. nuclear power reactor sites. Jamison, J.D. (Pacific Northwest Lab., P.O. Box 999, Richland, WA (US)); Stoetzel, G.A. vp of Proceedings of the twentyfirst midyear topical meeting of the Health Physics Society. Health Physics Society, McLean, VA (1987). (CONF-871202–: 21. mid-year topical meeting of the Health Physics Society: power reactor health physics, Bal Harbour, FL (USA), 13-17 Dec 1987).

Nuclear power reactor licensees are required by the U.S Code of Federal regulations, 10 CFR 50. 47 and 10 CFR 50 Appendis E, to be able to monitor and assess the offsite radiological consequences of an emergency condition at each reactor site. This capability is practiced and demonstrated regularity during drills and emergency response exercises evaluated by NRC inspectors. Licensees use a wide variety of different types of transportation, sampling and measuring techniques, survey instruments, recording and reporting methods and contamination control practices in meeting the requirements, This paper discusses the purpose of the environmental monitoring requirements, reviews common mistakes noted during drills and exercise, and presents a summary of good emergency environmental monitoring practice.

47161 Nuclear power plants: Using PSA to enhance operational safety. Lederman, L. (International Atomic Energy Agency, Vienna (Austria). Div. of Nuclear Safety); Tomic, B. *International Atomic Energy Agency Bulletin (IAEA),* 31(1): 39-43 (1989).

Developed as a logical extension of the old engineering discipline of reliability analysis, probabilistic safety assessment (PSA) was introduced in the commercial nuclear power field in the mid-1970s. To date, more than 70 PSAs have been carried out worldwide for nuclear power plants. The studies provide safety insights that could not have been obtained by other means. In most countries with nuclear power programmes, PSA has become a standard tool for safety evaluations. Briefly stated, PSA is a systematic method of modelling a plant's response to a set of initiating events that could threaten its safe operation. To develop the necessary models, detailed information regarding the plant's design and operation is needed. Basic models (such as fault or event trees) are developed to identify the success and failure paths. In analysing these models, a number of factors are taken into account, including the random failures of components, failures arising from a common cause, human errors, and test and operational strategies. Some PSAs have been initiated by electric power utilities in response to regulatory concerns or to demonstrate low public risks associated with nuclear power plant operations (e.g., at the Zion nuclear plant in the United States, and the Sizewell plant in the United Kingdom). Other PSAs have been sponsored by regulatory bodies to promote and develop the use of the techniques. Moreover, as the methodology has matured, PSA results have been increasingly used for improving the operational safety of nuclear plants.

47162 Basic safety principles for nuclear power plants: INSAG evaluation of the international response. *International Atomic Energy Agency Bulletin (IAEA),* 31(1): 44-45 (1989).

Short communication.

47163 Managing the effects of aging and reliability improvement. Hall, R.E. (Brookhaven National Lab., Upton, NY (USA). Dept. of Nuclear Energy); Gunther, W.; Boccio, J.L. *Nuclear Engineering and Design (Netherlands),* 115(2/3): 201-205 (Jul 1989). (CONF-8710111–: 15. water reactor safety information meeting (WRSM-15), Gaithersburg, MD (USA), 26-30 Oct 1987).

Over recent years the electric power generating community has acknowledged the importance of the aging process on plant safety and availability. To cope with time-dependent degradation phenomena that can affect active as well as passive components and lead to unacceptable, unanticipated failures requires research into the mechanisms of the aging process, advances in predictive methods for assessing the aging impact on risk and availability, and a better understanding of power plant operations so that strategies for defending against this pervasive stress can be developed. This paper discusses current research advances and presents a framework to aid in the systematic integration of these three needs. It also discusses current research in the aging effect on electric components. As such it is anchored to research being conducted at Brookhaven National Laboratory in the areas of plant aging, life extension, reliability, performance indication, and risk assessment. (orig.).

47164 United States Nuclear Regulatory Commission research program on molten core debris interactions in the reactor cavity. Burson, S.B. (Nuclear Regulatory Commission, Washington, DC (USA). Office of Research); Bradley, D.; Brockmann, J.; Copus, E.; Powers, D.; Greene, G.; Alexander, C. *Nuclear Engineering and Design (Netherlands),* 115(2/3): 305-313 (Jul 1989). (CONF-8710111–: 15. water reactor safety information meeting (WRSM-15), Gaithersburg, MD (USA), 26-30 Oct 1987).

The NRC's Research Program on Core-Debris/Cavity Interactions comprises two principal elements: (1) an analytical effort focused primarily on development of computer codes needed to predict the potential consequences of risk-significant severe-accident scenarios; and (2) an experiment component to provide insights into the relevant phenomenological processes and to develop the experimental data base necessary for validation of the codes. The analytical activities at Sandia National Laboratories (SNL) focus primarily in refinement and validation of the CORCON and VANESA codes. The major experimental activities are also based at SNL: (1) the large-scale SURC tests address the thermal-hydraulic phenomena in the cavity as well as aerosol release associated with prototypical core-melt materials in various types of concrete crucibles, while (2) the WITCH and GHOST experiments are concerned with aerosol generation and radionuclide release phenomena. A program of small-scale special-effects tests at Brookhaven National Laboratory (BNL) is coupled to a concomitant model-development and code-validation activity. In addition, measurements are being made at Battelle Columbus Laboratory (BCL) to augment the thermochemical data base needed in the VANESA code to permit refined radiological source-term predictions. The current scope and status of this research is reviewed. (orig.).

47165 The microstructural and microchemical characterization of samples from the TMI-2 core. Neimark, L.A. (Argonne National Lab., IL (USA)); Strain, R.V.; Sanecki, J.E.; Jackson, W.D. *Nuclear Engineering and Design (Netherlands),* 115(2/3): 315-321 (Jul 1989). (CONF-8710111–: 15. water reactor safety information meeting (WRSM-15), Gaithersburg, MD (USA), 26-30 Oct 1987).

Samples of materials from various regions of the TMI-2 reactor core and vessel have been examined at Argonne National Laboratory with a variety of microanalytical techniques. The purpose of these examinations is to characterize the microstructure and microchemistry of the materials so that their origin could be determined, their fission-product content evaluated, and their role in the accident scenario assessed. Macroscopic and microscopic composition inhomogeneities in melted fuel from different reactor locations indicate different cooling rates and solidification temperatures. The mobility of molten fuel could have been enhanced by a low temperature eutectic in the Fe-Cr-O system. Stainless steel-clad Ag-In-Cd control rods could have failed from a eutectic reaction between the Zircaloy guide tubes and the cladding. Significant concentrations of fission products were not found, but their release from the fuel did not appear to be enhanced by gas-generated channels along grain boundaries. (orig.).

47166 Experience of TSTA milestone runs with 100 grams-level of tritium. Anderson, J.L. (Los Alamos National Lab., NM (USA). Materials Science and Technology Div.); Bartlit, J.R.; Carlson, R.V.; Coffin, D.O.; Damiano, F.A.; Sherman, R.H.; Wilms, R.S.; Yoshida, H.; Yamanishi, T.; Naito, T. *Fusion Technology (USA),* 14(2): 438-443 (Sep 1988). (CONF-880505–: 3. topical meeting on tritium technology in fission, fusion and isotopic applications, Toronto (Canada), 1-6 May 1988).

The first loop operation tests of the Tritium Systems Test Assembly (TSTA) with 100 grams-level of tritium were performed at the Los Alamos National Laboratory (LANL) in June and July, 1987. The July run was resumption of the June run, which was halted because of a loss of cryogenic refrigerant in the hydrogen isotope separation system.

47167 MARCH calculations performed for the TMI-2 [Three Mile Island Unit] analysis exercise program. Wooton, R.O. *Transactions of the American Nuclear Society (USA),* 57: 444 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

As part of the validation effort for the MARCH portion of the Source Term Code Package, the U.S. Nuclear Regulatory Commission has requested Battelle Columbus to participate in the Three Mile Island Unit (TMI-2) Analysis Exercise Program. Previous TMI-2 calculations (1980) had been performed using the original MARCH 1.1 version of the code. MARCH was written to calculate thermal-hydraulic phenomena for reactor accidents leading to core

meltdown. The accident sequences normally considered by MARCH users are relatively uncomplicated. For example, multiple changes in emergency core cooling injection, steam generator auxiliary feedwater flow rates, and cycling of primary system steam relief valves are not generally considered in severe-accident analysis. All of these things were done during the TMI-2 accident. In addition, at TMI-2 the core meltdown sequence was interrupted by the restoration of core cooling after achieving significant melting. In order to perform meaningful TMI-2 calculations, it has been found necessary to add a number of modeling enhancements to MARCH. These modeling changes are discussed along with the results of the TMI-2 MARCH calculations in this paper.

47168 Summary of the results of the TMI-2 analysis exercise. Golden, D.W. *Transactions of the American Nuclear Society (USA),* 57: 444-446 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

This paper provides an overview of the current activities within the international consortium participating in the Three Mile Island Unit 2 (TMI-2) analysis exercise, which is part of the Nuclear Energy Agency/Department of Energy Joint Task Group (JTG) program on TMI-2, formed to utilize the TMI-2 accident as a benchmark for severe-accident computer codes. This is truly an international consortium and rightly so, since the accident at TMI-2 had international repercussions.

47169 Radiological conditions and experiences in the TMI-2 [Three Mile Island Unit 2] auxiliary building. Ruhter, P.E.; Zurliene, W.G. *Transactions of the American Nuclear Society (USA),* 57: 449 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

The accident at Three Mile Island Unit 2 (TMI-2) created circumstances that have seldom been encountered in the nuclear industry. These circumstances involved high radiation and contamination conditions in areas to which emergency access was required to maintain reactor control. The radiological conditions in the auxiliary building immediately following the accident, how those conditions varied from one location to another, and how they varied with time during the first 6 to 8 months required to return to some degree of normalcy are reviewed. The controls and methods used to maintain radiological exposures as low as reasonably achievable (ALARA) while the necessary work was completed, as well as the circumstances that led to non-ALARA exposures, are also described.

47170 Three mile island unit 2 postaccident reactor building entry program. Langenbach, J.W. *Transactions of the American Nuclear Society (USA),* 57: 449-451 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

In May 1979, following the March 28, 1979, accident at Three Mile Island Unit 2 (TMI-2), Metropolitan Edison Company established the Containment Assessment Task Force (CATF). The overall objective of the CATF was to evaluate the environment inside the reactor building to determine the feasibility of reactor building entry and to enter the reactor building if conditions permitted to gather data to be used to plan for reactor building decontamination, defueling, and cleanup. The decontamination of the containment atmosphere and the initial entry were considered to be the initial vital steps in the cleanup and the defueling of TMI-2. To accomplish the assigned duties, the CATF conducted a number of experiments to assess the in-containment environment. The data gathered from the experiments were utilized to prepare for the initial entries. The results of the entries demonstrated the conservatism in the preentry analysis, which assumed the worst case. The radiation levels were 100 to 1000 times less than the original estimates before the preentry experiments were performed and 2 to 3 times less than estimates based on the preentry experiments.

47171 Environmental measurements during the TMI-2 [Three Mile Island Unit 2] accident. Hull, A.P. (Brookhaven National Lab., Upton, NY (USA)). *Transactions of the American Nuclear Society (USA),* 57: 451-453 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

Although prior arrangements for it had not been developed in detail, an integrated state and federal environmental monitoring response was made to the Three Mile Island Unit 2 (TMI-2) accident. This paper deals with the emergency phase between March 28 and April 15, 1979, largely from the US Department of Energy (DOE) perspective. The early off-site response was made by the utility and the Pennsylvania Department of Environmental Resources (DER) with some assistance from the US Nuclear Regulatory Commission's (NRC) Region 1 office. Resources from DOE's Radiological Assistance Program (RAP) at Brookhaven National Laboratory and from its Aerial Measurements Service (AMS) arrived in Harrisburg ≈8h after the onset of the accident. Its Atmospheric Advisory Capability (AAC) at Lawrence Livermore National Laboratory (LLNL) commenced projections of the plume's trajectory and other DOE resources were altered. The DOE effort was gradually expanded during the following days, and by April 2 included ≈100 DOE radiation protection professionals and support personnel who were engaged in plume tracking, field environmental monitoring and sampling, sample analysis, and dose assessment.

47172 TMI [Three Mile Island] and the environment. Good, B.A. *Transactions of the American Nuclear Society (USA),* 57: 453-454 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

GPU Nuclear Corporation (GPUNC) operates the Three Mile Island (TMI) Nuclear Station, which houses two pressurized water reactors designated as TMI-1 and TMI-2. Since the 1979 accident at TMI-2, adverse comments regarding radioactive releases and off-site effects of the accident have received wide public attention. Allegations of inadequate effluent and environmental monitoring, cancer clusters, and plant and animal deformities have been made. Numerous radiation injury claims have been filed. Another potential Three Mile Island is a battle cry often used by antinuclear activists across the country against the nuclear power industry. The nuclear industry must be prepared to respond with the facts to these challenges. The realities and positive findings of the TMI accident and normal power plant operations should be publicized. To this end, three publications have been produced by GPUNC to tell the TMI radiological story. Radiation and Health Effects and TMI-1 and TMI-2 Exposure Reports provide information concerning potential health effects from the TMI-2 accident and worker occupational exposures, respectively. TMI and the Environment is a comprehensive report that describes radioactive effluent releases, off-site doses, and radiological environmental monitoring from 1974 through 1986. It will be updated annually to include the results of the previous year's monitoring. The report was written to be understood by the informed public and was distributed to local and regional media, public officials, interested citizens, and other utilities.

47173 The TMI-2 [Three Mile Island Unit 2] reactor building gross decontamination experiment: Effects on loose-surface contamination levels. Lazo, E.N. (Brookhaven National Lab., Upton, NY (USA)). *Transactions of the American Nuclear Society (USA),* 57: 455-456 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

In March 1982, the Gross Decontamination Experiment was conducted in the Three Mile Island Unit 2 (TMI-2) reactor building. The intent of the experiment was twofold: (a) to determine which of several commonly used decontamination techniques would be the most efficient at reducing contamination levels on vertical and horizontal surfaces and (b) to actually reduce radiation and surface contamination levels in the accessible areas of the reactor building in order to reduce person-rem expenditures for future entries. Accessible areas included the entire reactor building except inside the D-rings, inside the enclosed stairwell, and elevation 282 ft. The experiment was broken into six separate tasks, implemented by nine different work packages, and accomplished during 15 reactor building entries over a 30-day period. Approximately 40 person-rem were expended in completing the experiment. While the results of the experiment did show which decontamination techniques were the most effective, loose-surface contamination and radiation levels in the reactor building were not substantially reduced. The decontamination techniques tested and the key test parameters are shown.

47174 Surface activity characterization with TLD rings. Vallem, R.J.; Distenfeld, C.H.; Peterson, H.K. *Transactions of the American Nuclear Society (USA),* 57: 457 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

At Three Mile Island Unit 2 in the summer and fall of 1983, a major effort to reduce the reactor building exposure rates was evolving. A major data acquisition program was also evolving to provide the information that was needed to prioritize the dose reduction efforts. By the end of the year, there was enough information to know the major dose contributors and their relative contributions. The data that dealt with the floors indicated that their contribution was minor compared to other sources. It would not be long, however, before the major contributors to the exposure rates were mitigated and the minor contributors, like the floors, would become more important. At that point, the current data would be insufficient to effectively prioritize additional dose reduction work. A large part of that information gap would be filled because of the development and deployment of the thermoluminescent dosimeter rings.

47175 Using ex-core neutron detectors to estimate fuel quantities in the reactor vessel lower head. Rainisch, R.; Fricke, V. *Transactions of the American Nuclear Society (USA),* 57: 465-466 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

During the accident at Three Mile Island Unit 2 (TMI-2), a significant mass of core debris slumped to the bottom head of the reactor vessel. Defueling activities caused more core debris to relocate to the lower head region. The variations in the ex-core neutron detector, or source range monitor (SRM), readings gave evidence of this effect of defueling activity. Between October 1986 and November 1987, as a result of defueling the lower core region, increases in SRM rates were noted as 50% for NI-1 and 90% for Ni-2. Analysis of these increases shows that they correspond to lower head rubble bed mass increases of 30 to 50%, or between 6 and 8 tonnes of rubble. The above yields a total lower head inventory of between 21 and 28 tonnes of rubble; this equates to 15.5 to 21 tonnes of UO_2.

47176 Development of a dose algorithm for the modified panasonic UD-802 personal dosimeter used at three mile island. Miklos, J. A. (Univ. of Michigan, Ann Arbor (USA)); Plato, P. *Transactions of the American Nuclear Society (USA),* 57: 467 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

During the fall of 1981, the personnel dosimetry group at GPU Nuclear Corporation at Three Mile Island (TMI) requested assistance from The University of Michigan (UM) in developing a dose algorithm for use at TMI-2. The dose algorithm had to satisfy the specific needs of TMI-2, particularly the need to distinguish beta-particle emitters of different energies, as well as having the capability of satisfying the requirements of the American National Standards Institute (ANSI) N13.11-1983 standard. A standard Panasonic UD-802 dosimeter was modified by having the plastic filter over element 2 removed. The dosimeter and hanger consists of the elements with a 14 mg/cm^2 density thickness and the filtrations shown. The hanger on this dosimeter had a double open window to facilitate monitoring for low-energy beta particles. The dose algorithm was written to satisfy the requirements of the ANSI N13.11-1983 standard, to include ^{204}Tl with mixtures of ^{204}Tl with ^{90}Sr/^{90}Y and ^{137}Cs, and to include 81- and 200-keV average energy X-ray spectra. Stress tests were conducted to observe the algorithm performance to low doses, temperature, humidity, and the residual response following high-dose irradiations. The ability of the algorithm to determine dose from the beta particles of ^{147}Pm was also investigated.

47177 The significance of radiological control documentation in litigation. Lodde, G.M.; Murphy, T.D. *Transactions of the American Nuclear Society (USA),* 57: 469-470 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

Commercial nuclear facilities accumulate radiological control program data and documents generated and retained pursuant to regulatory, license, and technical specification requirements. During and following the Three Mile Island Unit 2 (TMI-2) accident, many documents were produced that would not normally have been produced. Shortly after the accident, the US Nuclear Regulatory Commission (NRC) issued an order requiring the retention of all data, including documentary material and physical samples relating to the TMI-2 accident (44 Fed. Reg. 30788, May 29, 1979). Three years later, the NRC vacated the requirement to retain catalogued physical samples, provided the radioactivity data had been properly recorded, allowing disposal of many samples. After the TMI-2 accident, GPU Nuclear Corporation (GPU) designed and implemented an effective and efficient record management program for TMI. This Computer-Assisted Records and Information Retrieval System (CARIRS) was developed to assess the official record for TMI, which is maintained as a microform. GPU also retains hard copies of selected radiological control documents for potential litigation. This paper describes the use of radiological control documentation in the postaccident litigation and the magnitude of document production required to support that litigation.

47178 Computer system development to support TMI-2 [Three Mile Island Unit 2] radiological controls, operations, and records management activities. Schauss, R.D. *Transactions of the American Nuclear Society (USA),* 57: 470-471 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

The regulations pertaining to the reporting and keeping of records pertaining to occupational radiation exposure of workers employed at US Nuclear Regulatory Commission (MRC) licensed facilities (licensees) are contained in 10CFR19 and 10CFR20, respectively. These regulations provide specific guidance concerning the types of occupational radiation exposure data that must be generated, tracked, reported, and preserved for individuals working at US nuclear power facilities. Certain forms, such as Form NRC-4 Occupational Radiation Exposure History and Form NRC-5 Current Occupational Radiation Exposure, are required to be maintained by the licensee, and specific guidance is provided as to the format and content of data to be documented on these forms. At the time of the accident, Metropolitan Edison Company (the operator of TMI-2), had in place a fairly comprehensive computerized radiation exposure control and record keeping system. The radiation exposure management (REM) system was maintained on the corporate mainframe computer and employed industry-accepted EDP standards for data entry and retrieval. It soon became apparent that the best approach would be to completely redesign the REM system to best meet the special requirements imposed by the accident situation, and the decision was made to design and develop a totally new REM computer system employing on-line transaction processing and an integrated data base management system.

47179 Dosimetry studies pertaining to the accident at TMI-2 [Three Mile Island Unit 2]. Auxier, J.A. *Transactions of the American Nuclear Society (USA),* 57: 474-475 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

The objectives of the dosimetry task group of the Kemeny Commission staff were to estimate the radiation doses to both Three Mile Island (TMI) workers and to the general public within 50 mi of the damaged reactor. At the beginning of the task group's work, it had access to hard data from the thermoluminescent (TLD) system only, and a detailed study was initiated to make use of these data. This study included calibration evaluations, considering the effects of photon energy and angle of incidence on response per unit exposure, as well as natural background and other factors that might influence the interpretation of the readings. A second set of data was developed during the analysis of the air-handling equipment of the auxiliary and fuel handling buildings. A third part of the task groups's work was directed toward the estimation of population doses based on both the TLD and vent release data. A final study by the task group involved the exposure of the on-site workers at TMI. It is noteworthy that, in the face of the dose estimates shown in the original and revised impact statement for the cleanup operation, the actual doses experienced in each facet of the cleanup generally have been less than projected, usually by a significant factor. Also, the annual person-rem totals for the cleanup have averaged less than those for a normal operating pressurized water reactor.

47180 Worker exposures during the TMI-2 [Three Mile Island Unit 2] recovery. Merchant, D. *Transactions of the American Nuclear Society (USA),* 57: 477-478 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

The purpose of this paper is review external and internal radiation exposures to workers involved in the Three Mile Island Unit 2 (TMI-2) recovery effort. The 1979 accident left the plant with several areas with uninhabitable radiation environments. The recovery necessitated many unique tasks never before attempted in the US commercial nuclear industry. Extensive planning, use of mockups, and robotic technology have helped keep individual and collective exposures acceptably low, while allowing the recovery to proceed expeditiously. The total whole-body collective dose for all TMI-2 workers from 1979 through 1987 was 4694 person-rem. It is expected that 6000 person-rem will have been expended before placing the plant into post-defueling monitored storage in mid-1989. This total is within the US Nuclear Regulatory Commission's original Programmatic Environmental Impact Statement (PEIS) estimate of 2,000 to 8,000 person-rem, and well below the revised PEIS estimate of 13,000 to 46,000 person-rem. The low individual and total exposures experienced by persons working at TMI-2 translate into low risk of adverse health effects.

47181 Radiation protection training then and now. Mulleavy, T. *Transactions of the American Nuclear Society (USA),* 57: 478-479 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

Prior to the accident at Three Mile Island, the radiological control training was provided by the health physics and the chemistry departments. The programs that required the input from the health physics department were the Operations Training and the General Employee Training Programs, which were formally organized and presented radiological controls practices as part of the course objectives. The operations training section periodically requested the health physics department management to provide a radiological portion to their operator qualification or operations requalification class. After the accident in 1979, the General Employee Training Program administration was taken over by the operation training department where it underwent changes with a dedicated effort. The Operations Training Program also underwent a change as well as the Radiological Control Technician Training Program. Each group now has a specialty program designed for their specific needs. These programs have been designed using the Institute of Nuclear Power Operations and regulator guidelines.

47182 Personnel contamination protection techniques applied during the TMI-2 [Three Mile Island Unit 2] cleanup. Hildebrand, J.E. *Transactions of the American Nuclear Society (USA),* 57: 481-482 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

The severe damage to the Three Mile Island Unit 2 (TMI-2) core and the subsequent discharge of reactor coolant to the reactor and auxiliary buildings resulted in extremely hostile radiological environments in the TMI-2 plant. High fission product surface contamination and radiation levels necessitated the implementation of innovative techniques and methods in performing cleanup operations while assuring effective as low as reasonably achievable (ALARA) practices. The approach utilized by GPU Nuclear throughout the cleanup in applying protective clothing requirements was to consider the overall health risk to the worker including factors such as cardiopulmonary stress, visual and hearing acuity, and heat stress. In applying protective clothing requirements, trade-off considerations had to be made between preventing skin contaminations and possibly overprotecting the worker, thus impacting his ability to perform his intended task at maximum efficiency and in accordance with ALARA principles. The paper discusses the following topics: protective clothing-general use, beta protection, skin contamination, training, personnel access facility, and heat stress.

47183 Control of the TMI-2 [Three Mile Island Unit 2] reactor building environment. Lodde, G.M.; Good, B.A.; Surgeoner, D.M. *Transactions of the American Nuclear Society (USA),* 57: 482-483 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

As a result of the March 28, 1979, accident at Three Mile Island Unit 2 (TMI-2), significant quantities of radioactive fission products, including gases, particulates, and iodine, were released into the enclosed reactor building atmosphere from failed fuel in the reactor core. Air samples of the reactor building atmosphere showed ^{85}Kr with a 10.7-yr half-life to be the principal remaining radionuclide. To permit less restricted access to the reactor building and to proceed toward decontamination of the TMI-2 facility, it was necessary to remove the ^{85}Kr and to provide a suitable environment for workers. The venting was conducted between June 28 and July 11, 1980. The paper discusses reactor building air sampling, venting of the reactor building, radioactivity released to the environment, and the internal dosimetry program.

47184 The role of radiation instruments in the recovery of TMI-2 [Three Mile Island Unit 2]. Behling, U.H.; Frank, G. *Transactions of the American Nuclear Society (USA),* 57: 483 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

Recovery, defueling, and restoration of Three Mile Island Unit 2 (TMI-2) to an environmentally stable configuration has been a labor-intensive effort that had to be conducted in complex radiological conditions of varying field intensities. Part of the success of the TMI-2 radiological controls program in minimizing worker exposure can be attributed to the effective use of a variety of portable instruments. A key component to the TMI-2 radiological controls program was the extensive characterization of source terms. Systematic surveys had to be conducted to quantify general radiation fields, locate hot spots, and establish surface contamination levels and airborne concentrations of radionuclides. Detailed and accurate radiological surveys and field measurements are essential to as low as reasonably achievable reviews, radiation work permit specifications for protective measures, and job briefings. Radiological instruments used at TMI include a variety of devices capable of assessing radiation fields from sealed sources, contaminated surfaces, and airborne radioactivity. At TMI, the maintenance and calibration of radiological instruments is conducted on site by a group of qualified technicians who are an integral part of the Radiological Controls Division. All calibration and repair is proceduralized and subject to a variety of audits, inspections, and internal and external assessments.

47185 Emergency response planning in Pennsylvania. Reilly, M.A. *Transactions of the American Nuclear Society (USA),* 57: 488-489 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

In the decade since the accident at Three Mile Island, emergency planning for response to these events has undergone a significant change in Pennsylvania, as elsewhere. Changes respond to federal guidance and to state agency initiatives. The most singular change is the practice of implementing a protective action throughout the entire emergency planning zone (EPZ). Due to Pennsylvania agency experiences during the accident, the decision was made soon after to develop a staff of nuclear engineers, each giving special day-to-day attention to a specific nuclear power station in the state. Changes in communications capabilities are significant, these being dedicated phone lines between the Commonwealth and each power station, and the reorientation of the Department of Environmental Resources radio network to accommodate direction of field monitoring teams from Harrisburg. Changes that are being or will be implemented in the near future include assessing the emergency response data system for electronic delivery of plant parameter data form facilities during accidents, increased participation in exercises, emergency medical planning, and training, the inclusion of all 67 counties in Pennsylvania in an ingestion EPZ, and the gradual severance of dependence on land-line emergency communication systems.

47186 The Three Mile Island Unit 2 accident and its impact on the NRC. Alexander, R.E.; Bell, J.M. *Transactions of the American Nuclear Society (USA),* 57: 489 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

The accident at Unit 2 of the Three Mile Island (TMI) nuclear power plant had a wide ranging affect on US Nuclear Regulatory Commission (NRC) programs. Many studies and investigations followed the accident, and many recommendations for change were included in the reports of these studies. These studies included the Special Inquiry Group (Rogovin) Report, the President's Commission (Kemeny) Report, the Health Physics Appraisal Program Report, and the TMI-2 Radiation Protection Program Report. Among the areas affected were operator training, control room design, utility management, emergency response planning, siting, engineered safety features, small-break loss-of-coolant accidents, distribution and assessment of relevant operational experience data, post-accident sampling, safety goals, the resident inspector program, and radiation protection programs, including equipment, facilities, and personnel adequacy. In addition, the recovery effort at TMI presented profound challenges in several areas of science and engineering, including radiation protection. Challenges presented by study and investigation findings and recommendations, and challenges emerging from the recovery process at TMI are examined. The NRC's responses to these challenges and their effects on the NRC's regulatory programs, with emphasis in the radiation protection area are discussed.

47187 Programmatic changes due to TMI-2 [Three Mile Island Unit 2]: Accident planning. Wingert, V.L. *Transactions of the American Nuclear Society (USA),* 57: 489-490 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

The focus of the paper is lessons learned for emergency planning and preparedness form the Three Mile Island Unit 2 (TMI-2) accident. The lessons learned are examined from two perspectives: (a) lessons learned that have resulted in programmatic changes, and (b) lessons learned that have not been adequately addressed. There is no doubt that the TMI-2 accident is the pivotal event that caused a major rethinking of the pre-TMI emergency preparedness posture and led to a fundamentally different approach to emergency preparedness for commercial nuclear power plant accidents. While this new approach has evolved into a comprehensive, systematic, and even prototypical national program, it has also generated new problems: escalating costs for state and local governments and leveraging of the federal licensing process by state and local governments who do not want specific nuclear power plants to operate. A discussion of the primary lessons learned on emergency preparedness is presented under the following topics: beyond defense-in-depth, predetermined action, mandatory emergency planning and preparedness, and federal coordination.

47188 The Department of Energy response to TMI [Three Mile Island]. Musolino, S.V. (Brookhaven National Lab., Upton, NY (USA)). *Transactions of the American Nuclear Society (USA),* 57: 490 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

The US Department of Energy (DOE) was and continues to be one of the principal federal agencies responding to the accident at Three Mile Island. The initial DOE response was via the Region-1 Radiological Assistance Program (RAP). Following this initial response, the Interagency Radiological Assistance Plan (IRAP) was activated, which brought in the resources of the national laboratories and other federal agencies to help perform the off-site dose assessment. It also included extensive logistical support of the field activities. After the accident, DOE became the lead agency to implement lessons learned with respect to coordinating the off-site radiological monitoring aspects of radiation emergencies. The DOE has recently provided a retrospective review of the environmental data collected during the accident. The DOE has been involved in the cleanup and assessment of the containment building and core removal. Oak Ridge National Laboratory has provided robotics for the cleanup effort and the Idaho National Engineering Laboratory (INEL) was designated to receive and analyze the damaged reactor core. Chemical and physical analyses of the core are ongoing at INEL.

47189 Disassembly and defueling of the TMI-2 [Three Mile Island Unit 2] reactor vessel lower core support assembly. Austin, W.E.; Porter, L.H. *Transactions of the American Nuclear Society (USA),* 57: 495-497 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

Planning for the disassembly and defueling of the Three Mile Island Unit 2 (TMI-2) reactor lower core support assembly (LCSA) began early in 1985. Evaluations of methods of defueling were performed based on various assumed LCSA conditions. Tooling was conceptualized and various defueling sequences were evaluated. As defueling of the core region progressed, information and data were obtained that clearly showed that a large amount of fuel was located within the LCSA and an even larger amount was located below the LSCA in the lower head of the vessel. It became apparent that it would be impractical to defuel this area of the reactor without massive cutting of the structural steel internal components. A plan was developed to defuel the LCSA by using two techniques: (a) core-boring LCSA components that had a round configuration (support posts and in-core instrument guide tubes) and (b) plasma arc cutting of components, which required linear cutting (plates and forgings). This paper describes the approach to LCSA disassembly, including the design basis of the equipment and sequence of in-vessel operations.

47190 Disassembly and defueling of the upper core support assembly. Rodabaugh, J.M. *Transactions of the American Nuclear Society (USA),* 57: 497-498 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

During normal operation of the reactor plant, the upper core support assembly (UCSA) holds the fuel assemblies in a defined geometry and establishes the flow path of the reactor coolant in the reactor vessel. Sometime during the course of the Three Mile Island Unit 2 accident, molten core material melted through a portion of the UCSA and flowed outside the confines of the core region into normally inaccessible areas. As a result, the UCSA must now be disassembled to remove the relocated core material. The paper includes UCSA description, a discussion of equipment design basis, and a discussion of the defueling approach.

47191 Operations and achievements of remote equipment at TMI-2 [Three Mile Island Unit 2]. Pavelek, M.D. II; Underhill, W.; Boudreaux, J.; Bozorgi, F.L. *Transactions of the American Nuclear Society (USA),* 57: 502-504 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

The Three Mile Island Unit 2 (TMI-2) project team evaluated teleoperators and robotic devices to participate in recovery work. The team carefully evaluated available options with client personnel. The goals of an as low as reasonably achievable (ALARA) radiation protection program and safe, efficient cleanup of the facility were the primary program objectives. Teleoperators that met our requirements were not commercially available in 1980. The project team worked closely with Carnegie-Mellon University, which produced with remote reconnaissance vehicles (RRVs) that conducted the major recovery operations in the reactor building basement. The RRVs provided the capability to deliver multitudes of remotely controlled and robotic devices for extended time periods to the reactor building basement at TMI-2, as well as other hostile environments. The teleoperator experience gained in this program is comprehensive and diverse.

47192 Development of an underwater remote manipulator system for use in TMI-2 [Three Mile Island Unit 2] reactor defueling. Vervaet, D.; Porter, L.H.; Dzikowski, R.J. *Transactions of the American Nuclear Society (USA),* 57: 504 (1988). (CONF-881011–: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

Defueling operations in the original core region of the Three Mile Island Unit 2 (TMI-2) reactor vessel were conducted with long-handled tools that were manually positioned by operators on a rotating work platform over the reactor vessel. The difficulties encountered with these operations led GPU Nuclear Corporation (GPU) to consider other means of operation when defueling the core support assembly and reactor vessel lower head, which is ≈12 m (40 ft) below the work platform. GPU determined a heavy-duty remote manipulator system could be an effective alternative. The MANFRED (MANipulators For REactor Defueling) system was thus

developed for this purpose by Ocean Systems Engineering and International Submarine Engineering under contract to GPU. The paper includes a description of MANFRED present status, and lessons learned.

47193 Performance of the automated cutting equipment system during the plasma cutting of the TMI-2 [Three Mile Island Unit 2] lower core support assembly. McGough, M.S.; Austin, W.E.; Knetl, G. *Transactions of the American Nuclear Society (USA),* 57: 504-505 (1988). (CONF-881011--: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

The lower core support assembly (LCSA) of the Three Mile Island Unit 2 (TMI-2) reactor was not structurally damaged during the accident. To permit defueling of that region of the core, the LCSA was cut to permit access. A five-axis teleoperator was developed to deliver plasma cutting, rotary grinding, and abrasive water jetting end effectors to the LCSA. Complex geometry sectioning was completed in a mockup facility at chemistry and pressure conditions simulating those of the vessel, prior to actual in-vessel operations. In-vessel activities began in early May of 1988. This paper presents the details of the in-vessel cutting efforts.

47194 Summary, retrospect, and evolution of mobile remote systems. Osborn, J.; Champeny, L.; Fromme, C.; Whittaker, W.L. *Transactions of the American Nuclear Society (USA),* 57: 506 (1988). (CONF-881011--: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

Many applications for mobile remote systems exist in the nuclear industry, particularly where such a work force can reduce human exposures or enable task performance where the capabilities of human workers are inadequate. Despite these opportunities, current remote technology is insufficient. The nuclear industry has pioneered equipment for remote manipulation and some specialized forms of mobility (legged, articulated tracks and hybrid locomotion), but few systems have been developed that integrate suitable manipulation, locomotion, environmental hardening, and other necessary features. A new class of equipment, remote work systems, specialized to nuclear applications, will ensue from this foundation and will be contingent on an understanding of the essential remote work system features and the ability to incorporate them in a capable system. Tasks that are candidates for use of mobile remote equipment exist throughout the life cycle of nuclear industry facilities. These include surveillance and inspections, maintenance of plant equipment, decontamination, waste handling, and decommissioning. Although work site conditions vary greatly and tasks can span such diverse objectives as passive inspection to active demolition, all applications require remote equipment that is mobile, reliable, capable, operable, decontaminable, maintainable, extensible, and compatible with the facility.

47195 Criticality analysis support for TMI-2 [Three Mile Island Unit 2] fuel removal operations. Parks, C.V. (Oak Ridge National Lab., TN (USA)); Westfall, R.M. *Transactions of the American Nuclear Society (USA),* 57: 507-508 (1988). (CONF-881011--: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

Beginning in 1984, the Three Mile Island Unit 2 (TMI-2) defueling design team requested Oak Ridge National Laboratory to supply criticality safety licensing and support analyses for all fuel removal operations. This paper discusses (a) the computational methods and basic analytic models employed in the work, (b) the areas where computational analyses were requested, and (c) pertinent results and indicates their impact on the defueling effort.

47196 Criticality prevention during postaccident decontamination of TMI-2 [Three Mile Island Unit 2] plant systems. Palau, G. L. *Transactions of the American Nuclear Society (USA),* 57: 509-510 (1988). (CONF-881011--: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

Following the accident at Three Mile Island Unit 2 (TMI-2), the likelihood of a criticality outside of the reactor coolant system (RCS) during the plant cleanup was very small. Given the consequence of any possible critical event in the TMI-2 systems, However, it was always necessary to ensure that all steps were taken to prevent criticality. Therefore, engineered controls were developed to ensure that decontamination of plant systems containing fuel material could be conducted in a manner that precluded criticality.

47197 Application of three-dimensional computer solids modeling to TMI-2 [Three Mile Island Unit 2] defueling activities. Schauss, R.D.; Cowser, D.K.; Kelley, M.J. *Transactions of the American Nuclear Society (USA),* 57: 511-513 (1988). (CONF-881011--: Joint meeting of the European Nuclear Society and the American Nuclear Society, Washington, DC (USA), 30 Oct - 4 nov 1988).

In February 1985 work was begun to develop a three-dimensional computerized solids model of the Three Mile Island Unit 2 (TMI-2) reactor building systems and facilities. Although it was initially planned to use this model to support the acquisition of data for radiological characterization, the unique ability of the modeling system to integrate plant configuration data into a single source made it an ideal tool for supporting various other TMI-2 recovery engineering activities as well. In addition to the reactor building model, models of the auxiliary and fuel handling buildings and a very detailed model of the TMI-2 reactor have also been developed. The application and use of the reactor model to support activities related to reactor vessel defueling and reactor components disassembly are the primary subjects of this paper, particularly as they relate to each area of the TMI-2 defueling organization.

47198 INEL [Idaho National Engineering Laboratory] hot shop contamination control during TMI-2 [Three Mile Island Unit 2] core debris handling. Croft, L.D.; Yeazel, J.A. *Transactions of the American Nuclear Society (USA),* 55: 677-678 (1987). (CONF-8711195--: American Nuclear Society winter meeting, Los Angeles, CA (USA), 15-19 Nov 1987).

The Idaho National Engineering Laboratory (INEL) houses unique hot cell/hot shop facilities used for remote handling and processing of highly contaminated and radioactive nuclear fuels and materials. These facilities are currently being used to handle, examine, and temporarily store Three Mile Island Unit 2 (TMI-2) core debris. These processes have created difficult but achievable challenges to control radioactive contamination spread within these facilities and maintain improving as-low-as-reasonably-achievable (ALARA) trends. This paper presents approaches and resolution to radiation exposure reduction and contamination control challenges incurred as part of the processing of TMI-2 core debris.

47199 LOCA [loss-of-coolant accident] analysis of a proposes power increase for MURR [Missouri University Research Reactor] using RELAP5/MOD2. Wang, J.L. (Univ. of Missouri, Columbia (USA)); Kunze, J.F.; McKibben, C.J. *Transactions of the American Nuclear Society (USA),* 55: 698-699 (1987). (CONF-8711195--: American Nuclear Society winter meeting, Los Angeles, CA (USA), 15-19 Nov 1987).

The University of Missouri Research Reactor (MURR) has been licensed to operate at 10 MW power since 1974. A preliminary study to increase its present power to a much higher level (≈30 MW) shows that this is readily achievable for steady-state operating conditions. The methods used to approach the goal of power upgrade operation include the flattening of the radial power distribution by varying the fuel loading of the plates, and the changing of operating conditions so as to provide a somewhat higher flow rate and greater heat exchanger capability. These changes are easily accomplished without major alterations to that portion of the primary system within the pool portion of the loop. However, one of the principal considerations in the power upgrade study for licensing is the loss-of-coolant accident (LOCA), which is addressed in this analysis.

47200 Assessment of the RETRAN02/MOD3 and RELAP5/MOD2 pressurizer model. Wang, Songfend; Wu, Chengchi; Wang, Jongrong. *Transactions of the American Nuclear Society (USA),* 55: 704-705 (1987). (CONF-8711195--: American Nuclear Society winter meeting, Los Angeles, CA (USA), 15-19 Nov 1987).

The pressurizer in pressurized water reactor (PWR) power plants plays an important role in determining the pressure history of the primary coolant system. Thus, accurate modeling of the pressurizer is needed to simulate overall PWR power plant behavior during transients. The purpose of this paper is to present an assessment of

the pressurizer model in the RETRAN02/MOD3 and RELAP5/MOD2 codes by using data from nuclear power plants, which include two tests at the Maanshan power plant, one test at the Shippingport nuclear power plant, and the Three Mile Island (TMI) accident. The results are shown to be in good agreement with the test data.

25 ENERGY STORAGE

2501 Magnetic

47201 (LA-UR–89-2877) **ANTHEM simulation of plasma opening switches.** Mason, R.J.; Jones, M.E.; Bergman, C. Los Alamos National Lab., NM (USA). 1989. 14p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-890665–46: 7. Institute of Electrical and Electronics Engineers pulsed power conference, Monterey, CA (USA), 12-14 Jun 1989). Order Number DE89016617/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Plasma Opening Switches have been examined numerically with the aid of the ANTHEM plasma simulation model. A generic bicylindrical switch is studied. The switching of generator pulses ranging from 50 ns to 1 μsec is reviewed. for a variety of plasma fill lengths and densities, and for a range of resistive loads. 7 refs., 9 figs.

2506 Thermal

47202 (PNL–6845) **Commercialization of aquifer thermal energy storage technology.** Hattrup, M.P.; Weijo, R.O. Pacific Northwest Lab., Richland, WA (USA). Sep 1989. 32p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC06-76RL01830. Order Number DE89017903/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Pacific Northwest Laboratory (PNL) conducted this study for the US Department of Energy's (DOE) Office of Energy Storage and Distribution. The purpose of the study was to develop and screen a list of potential entry market applications for aquifer thermal energy storage (ATES). Several initial screening criteria were used to identify promising ATES applications. These include the existence of an energy availability/usage mismatch, the existence of many similar applications or commercial sites, the ability to utilize proven technology, the type of location, market characteristics, the size of and access to capital investment, and the number of decision makers involved. The in-depth analysis identified several additional screening criteria to consider in the selection of an entry market application. This analysis revealed that the best initial applications for ATES are those where reliability is acceptable, and relatively high temperatures are allowable. Although chill storage was the primary focus of this study, applications that are good candidates for heat ATES were also of special interest. 11 refs., 3 tabs.

2507 Liquefied Gas

47203 (N–89-21419) **Cryogenic reactant storage for lunar base regenerative fuel cells.** Kohout, L.L. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. 1989. 30p. (NASA-TM–101980;E–4679;NAS–1.15:101980;CONF-8906169–: International Astronautics Federation conference on space power, Cleveland, OH (USA), 5-7 Jun 1989). Available from NTIS, PC A03/MF A01.

There are major advantages to be gained by integrating a cryogenic reactant storage system with a hydrogen-oxygen regenerative fuel cell (RFC) to provide on-site electrical power during the lunar night. Although applicable to any power system using hydrogen-oxygen RFC's for energy storage, cryogenic reactant storage offers a significant benefit whenever the sun/shade cycle and energy storage period approach hundreds of hours. For solar power installations on the moon, cryogenic reactant storage reduces overall specific mass and meteoroid vulnerability of the system. In addition, it offers synergistic benefits to on-site users, such as availability of primary fuel cell reactants for surface rover vehicles and cryogenic propellants for OTV's. The integration involves processing and storing the RFC reactant streams as cryogenic liquids rather than pressurized gases, so that reactant containment (tankage per unit mass of reactants) can be greatly reduced. Hydrogen-oxygen alkaline RFC's, GaAs photovoltaic (PV) arrays, and space cryogenic processing/refrigeration technologies are assumed to be available for the conceptual system design. Advantages are demonstrated by comparing the characteristics of two power system concepts: a conventional lunar surface PV/RFC power system using pressurized gas storage in SOA filament wound pressure vessels and, that same system with gas liquefaction and storage replacing the pressurized storage. Comparisons are made at 20 and 250 kWe. Although cryogenic storage adds a processing plant (drying and liquefaction) to the system plus 30 percent more solar array to provide processing power, the approximate order of magnitude reduction in tankage mass, confirmed by this analysis, results in a reduction in overall total system mass of approximately 50 percent.

2509 Batteries

47204 (AD-A–207612/3/XAB) **Advanced calcium-thionyl chloride high-power battery. Final report, 23 December 1987-22 December 1988.** Peled, E. Ramat-Tel-Aviv Univ. Authority for Research and Industrial Development Ltd. (Israel). 8 Feb 1989. 91p. Available from NTIS, PC A05/MF A01.

Recently, TAU has made a breakthrough in the development of two advanced calcium-thionyl chloride systems with much better storage properties than the state-of-art Ca-SOC_{12} cell. This was done by replacing the CaX_2(X=A1C_{14}) electrolyte by SrX_2 (type A), or BaX_2 type B. The project's goals are to gain a better understanding of the electrochemistry of the advanced systems and to establish their safety and performance. This report contains four chapters. The calorimetric study of Ca/Sr(A1C_{14})^2-SOC_{12}+7%(v/v)SO_2 C-size cells during constant-temperature discharge is reported in chapter 1. Fresh and stored (70 C for four weeks) cells were discharged inside a dedicated home-made calorimeter on two loads. There was no significant difference between fresh and stored cells with respect to heat generation during discharge. There was no loss in capacity during four weeks of storage at 70 C. Chapter 2 presents a calorimetric study of the baseline cell Ca/Ca(A1C_{14})^2-SOC_{12} + 7% (V/V)SO_2. Chapter 3 presents the performance, safety and storage properties of Ca/CaX_2 and CA/SrX_2 cells. Chapter 4 presents a summary of the results regarding the properties of MX_2-SO_2-TC solutions (M=Ca,Sr,Ba) including Raman spectra, viscosity and conductivity data. The effect of SO_2 and temperature on the conductivity and conduction mechanism we explained.

47205 (PB–89-173371/XAB) **Doped carbon electrodes for zinc-halogen batteries. Final report, February 1986-July 1986.** Malachesky, P.A.; Klimas, K.I. Stonehart Associates, Inc., Madison, CT (USA). Jul 1986. 38p. Available from NTIS, PC A03/MF A01.

The research project aimed at improving the life of conductive, carbon plastic electrode materials used in advanced, flowing electrolyte zinc-halogen battery systems. It was specifically directed at reducing the bromine-induced structural deformation or warpage which occurs in the bipolar plastic-bonded carbon electrode due to the volume changes which result from significant bromine absorption into the carbon-based bipolar plate. The basic approach involved the use of boron as a dopant which is substitutionally introduced into the carbon lattice. Such boron doping lowers the Fermi level of the carbon and was anticipated to inhibit bromine absorption, and, therefore, warpage. Research results indicate that boron doping of high surface carbons does lead to measurable decreases (up to 44%) in bromine absorption.

47206 (PB–89-184063/XAB) **Production of EMD (electrolytic manganese dioxide) under different gas atmospheres and its application as a cathode material for lithium secondary batteries.** Yoshio, M.; Noguchi, H.; Kurimoto, H.; Inoue, S.; Holzleithner, K. Asahi Glass Co. Ltd., Yokohama (Japan). Research Lab. 1988. 11p. Available from NTIS, PC EE12/MF A01.

Text in Japanese. Included in Reports of the Asahi Glass Foundation for Industrial Technology, Vol. 53, 261-270(1988).

The preparation of electrolytic manganese dioxide (EMD) by the electrolysis of $MnSO_4/H_2SO_4$ electrolyte with various gas feeding was presented. X-ray diffraction (XRD) pattern, discharge behavior, and other physicochemical properties of the EMD obtained from the

electrolyte under various gas atmospheres were compared with common (no gas feeding) EMDs. The higher (11) peak intensity of gamma-MnO_2 was obtained uder low current densities and N_2 gas atmosphere electrolysis, which subsequently gives a high (110) peak intensity in beta-MnO_2 made by heating the gamma-MnO_2 to about 400 C for 20 hours. The beta-MnO_2 can be effctively used as a cathode material for lithium secondary batteries. The capacity of lithium secondary batteries has been masured and cycle tests have been done, in order to compared these new beta-MnO_2 with those obtained from other EMDs. The change of the crystal structure of the EMD during repeated charge/discharge cycles, was confirmed by XRD after several cycles and the results were discussed from the view of the intercalation of lithium ions into the beta-MnO_2 structure.

47207 (SAND–89-2136C) **Sodium/sulfur battery studies at SNL [Sandia National Laboratories].** Braithwaite, J.W.; Freese, J.M. Sandia National Labs., Albuquerque, NM (USA). 1989. 12p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. (CONF-8909181–1: Electric and hybrid vehicle contractors' meeting, Idaho Falls, ID (USA), 6-8 Sep 1989). Order Number DE89016766/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Over the past decade, Sandia National Laboratories has managed the Department of Energy (DOE)-sponsored programs for the development of the sodium/sulfur battery technology. Two DOE offices have provided support for these programs: the Office of Energy Storage and Distribution (OESD) and the Office of Transportation Systems (OTS). The ultimate goal of these ongoing efforts is to develop and demonstrate high performance, cost-effective systems suitable for both stationary and mobile applications. A part of Sandia's responsibility is to evaluate the status of the technologies and to address specific problems that are encountered during the development process. The number and level of effort devoted to these tasks are scaled such that the funding emphasis is given to the contracted engineering development programs. Two of the major safety-related concerns with sodium/sulfur EV batteries are the potential consequences associated with large temperature increases and vehicle accidents. The first three tasks represent Sandia's initial effort to help identify effective methods to limit the temperature rise in the battery during both expected and unexpected conditions and to assess one possible result of a vehicle accident. Descriptions of each task along with selected results are given in the following sections. 4 figs., 2 tabs.

29 ENERGY PLANNING AND POLICY

2901 Energy Analysis and Modeling

Refer also to citation(s) 47249, 47250

47208 (ORNL/TM–11146) **Life cycle cost analyses of US Air Force heating plants.** Wilkinson, V.K. Oak Ridge National Lab., TN (USA). Aug 1989. 31p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. Order Number DE89015672/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The purpose of this study was the development of a life cycle costing forecasting methodology for US Air Force heating plants and the translation of the resulting cost estimating relationships (CERs), algorithms, and data into a Heating Plant Cost Analysis Model. The model and methodology can be used for day-to-day cost trade-off analyses for both new equipment installation and modifications of existing facilities. The overall objective of the effort was to provide the Air Force, through the Air Force Engineering and Services Center (AFESC), a defensible plan to meet the provisions of a Defense Appropriation Act which directed that a program be implemented to rehabilitate and convert current heating plants at US defense facilities to allow them to use coal. 15 refs., 5 figs., 6 tabs.

47209 (PB–89-187918/XAB) **National Energy Accounts, 1958-1985. Technical report (Final).** Faucett (Jack) Associates, Bethesda, MD (USA). Feb 1989. 310p. (JACKFAU–89-351). Available from NTIS, PC A14/MF A01.

Supersedes PB–85-142024.

This report provides technical documentation of the methodology used in updating the National Energy Accounts data base. The National Energy Accounts represent a balanced, annual account of all sources and uses of energy in the U.S. economy from 1958 through 1985. The detailed data base (available separately from the U.S. Department of Commerce) includes 131 sectors of the economy, 16 functional use categories, and 36 energy products. Annual levels of consumption, production and inventory are reported in BTU's, physical units, current dollar value, and constant (1982) dollar value.

2902 Economics and Sociology

Refer also to citation(s) 47242, 47251, 48073

47210 (DOE/IG–0271) **Audit of the use of annual appropriations to fund contracts.** USDOE Office of Inspector General, Washington, DC (USA). Capital Regional Office. 31 Aug 1989. 7p. Sponsored by U.S. DOE Management & Administration. Available from OSTI.

The purpose of this audit was to determine whether annual appropriations (annual funds) were being properly administered by the Department of Energy (Department). Specifically, we wanted to determine whether annual funds were being used to fund contracts beyond the year for which the funds were available. The Department receives more than $13 billion each year to finance its activities. The majority of this money is received through "no-year" appropriations, which can be retained by the Department until they are spent. About $80 million each year is received through annual funds, which are restricted to pay for the activities needed in the year for which the funds are provided. Unless specifically authorized by the Congress, annual funds not needed at the end of the year are to be returned to the Treasury.

47211 (ETDE/CA-MS–BT31-2-1988-III-13) **Energy, Mines and Resources Canada, 1987-88 estimates. Part 3, expenditure.** Department of Energy, Mines and Resources, Ottawa, ON (Canada). 1987. 415p. (In English and French). (MICROLOG–87-02838). Available from Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; $20.00; OTHER COUNTRIES: $24.00 CAN; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1; $10 CAN.

Energy, Mines and Resources Canada was established in 1966 and has since undergone a number of organizational changes, mainly in the energy sector. Its responsibilities lie in the areas of energy research and development, and policy implementation and development, in such fields as mineral resources, nonconventional materials, conservation and alternative energy, and enhancement of energy and mineral markets. This document presents budgetary estimates, along with summaries of departmental objectives and programs, of the Administration, Energy, and Minerals and Earth Sciences Programs of the organization. Under each Program is included an overview of plans and highlights of recent performance, an analysis of activity in each sector of the program, and a profile of program resources and other information. 5 figs., 86 tabs.

47212 (ETDE/CA-MS–M-22-105-1988) **Free trade and energy.** Department of Energy, Mines and Resources, Ottawa, ON (Canada). 1988. 42p. (In English and French). (MICROLOG–89-03033). Available from Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; $N/C; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1; $10 CAN.

This booklet was prepared and issued by the federal Department of Energy Mines and Resources to explain some of the energy implications of the Canada-U.S. Free Trade Agreement. The booklet covers economic opportunities, including secure and expanded market access for petroleum, natural gas, electricity, uranium, and petrochemicals, and access to increased amounts of capital to develop those megaprojects projected to play an increasing role in domestic energy production. Another important aspect is that of energy security, best achieved through the effective functioning of markets and their openness to international influences. The final question dealt with is that of sovereignty. The booklet points out that Canada retains its existing right to create energy policies and

programs, ownership of resources remains with the provinces, and the Government of Canada retains regulation of foreign ownership in the oil and gas industry. The conclusion places the Canada-U.S. Free Trade Agreement on the spectrum of similar moves to remove trade barriers and increase international trade opportunities.

2903 Environment, Health, and Safety

Refer also to citation(s) 46841, 46924, 46940, 46941, 47148, 47159, 47160, 47256, 47293, 47298, 47964, 47967, 47968, 47969, 47970, 47999, 48000, 48001, 48002, 48003, 48004, 48005, 48006, 48007, 48008, 48009, 48010, 48011, 48041, 48051, 48052, 48053, 48054, 48055, 48056, 48057, 48058, 48059, 48060, 48061, 48062, 48063, 48064, 48065, 48066, 48067, 48068, 48069, 48070, 48071, 48072, 48073, 48074, 48075, 48076, 48077, 48078, 48079, 48080, 48081, 48156

47213 (CONF-881054–Vol.3, pp. 809-819) **Implementation and management of waste minimization programs at federal facilities.** Vogel, R.A. (Lee Wan and Associates, Oak Ridge, TN (USA)). Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 3.* Order Number DE89014702/JAW. Available from NTIS, PC A14/MF A01.

This paper discusses institutional waste minimization options and methods as a way of involving all levels of management in waste minimization at federal facilities. With the passage of the Resource Conservation and Recovery Act (RCRA) and the subsequent Hazardous and Solid Waste Amendments (HSWA) of 1984, waste minimization programs at federal facilities have become necessary as well as practical, with regulatory as well as economic requirements driving the need. Federal facility managers are developing and implementing waste minimization programs that they feel are compatible with their operations. Some managers rely on technical solutions while others search for reductions through institutional programs. The best programs combine institutional minimization options with technical options and involve all levels of personnel in the implementation. Program involvement increases with education, incentives and implementation of initial technical options.

47214 (CONF-881054–Vol.3, pp. 837-848) **A tracking system for hazardous waste minimization.** Martino, L.E. (Argonne National Lab., Washington, DC (USA)); Shen-Yann Chiu; Peters, R.W.; Wentz, C.A.; Habegger, L.J.; Donahue, B. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. DOE Contract W-31-109-ENG-38. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 3.* Order Number DE89014702/JAW. Available from NTIS, PC A14/MF A01.

A successful waste minimization program must include the development of a reliable system for tracking waste types, volumes, and generation points. Once such a system is in place, process engineers should be capable of developing minimization alternatives to achieve the program goals. This study involved the development of a waste tracking system based on bar code technology. The tracking system utilizes a dBase III Plus data base and a software program known as Barcode. The program assigns a bar code to each hazardous material container at the time of receipt for use in keeping track of its location at the facility. Bar codes can be similarly assigned for hazardous wastes at the time of generation. Handheld bar code readers are then used to read the labels whenever the items are shipped, received, or used. This tracking system differs from other commercially available tracking systems in that it permits collection of data at the unit operation level as well as at a plantwide level.

47215 (CONF-881054–Vol.3, pp. 849-860) **Waste minimization at Vandenberg Air Force Base - cast studies.** Zirps, N.A. (ICF Technology Inc., Fairfax, VA (USA)); Shaver, D.K.; Held, K. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 3.* Order Number DE89014702/JAW. Available from NTIS, PC A14/MF A01.

The Waste Minimization Feasibility Study for Vandenberg Air Force Base (VAFB) covers a wide variety of operations that occur at many other DOD facilities. Operations analyzed include component cleaning, electroplating, paint stripping, waste oil changeout, field and paint booth painting, photoprocessing and silver recovery, vapor degreasing, engine flushes, and launch related operations. For the processes analyzed, a 94% overall waste reduction was determined to be feasible at an annual savings in operating and waste disposal costs of $300,000. This initial feasibility screening indicates promising results for waste minimization exemplified by several case studies. However, this initial screening is only the first step in the waste minimization process. Considerable testing of potential substitutes and modification of Specifications and T.O.s are crucial to the successful implementation of waste minimization technologies.

47216 (CONF-881054–Vol.3, pp. 877-887) **Application of minimization techniques to metal preparation and finishing operations in the Air Training Command.** Teichert, W.P. (Lee Wan and Associates, Inc., Oak Ridge, TN (USA)); Gant, R.E.; Saenz, J. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 3.* Order Number DE89014702/JAW. Available from NTIS, PC A14/MF A01.

Waste minimization programs were developed for selected US Air Force (USAF) Air Training Command (ATC) bases. The primary generators of hazardous waste at these locations are metal preparation and finishing operations. Elements of these operations include metals polishing, parts cleaning, surface preparation, coating application, and coating removal that are performed in a cyclical manner dependent upon maintenance needs. A case study of minimization techniques applicable to metal polishing operations is provided. The implemented options involve sludge separation, increased efficiency rinsing, material substitution, and modified waste disposal methods. Reduction economics and rationale are presented for the selected design.

47217 (CONF-881054–Vol.3, pp. 891-902) **Supplemental RI/FS (Remedial Investigation/Feasibility Study) guidance for Federal facilities.** Wardwell, R.E. (E. C. Jordan Co., Portland, ME (USA)); Ikalainen, B.H.; Hathaway, J.R. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 3.* Order Number DE89014702/JAW. Available from NTIS, PC A14/MF A01.

Remedial Investigation/Feasibility Study (RI/FS) Guidance Documents have been prepared and distributed by the Environmental Protection Agency (EPA) for use at Superfund sites. One goal of EPA studies is to provide the documentation necessary to support litigation. Federal facilities have been mandated to finance and perform their own remedial actions, and generally have different source characteristics than EPA sites. For these reasons, RI/FS at Federal facilities can be more streamlined and focused, which accelerates the initiation of clean-up actions. This paper provides supplemental guidance on the steps necessary to perform RI/FS at Federal facilities. Comparisons will be made between the EPA process and the process followed at Federal facilities. The rationale for the differences between the programs will be discussed.

47218 (CONF-881054–Vol.3, pp. 923-929) **Developing a programmatic approach to investigating and remediating many unrelated comprehensive environmental response, compensation and liability act sites at Kelly Air Force Base.** Kamp, G. (Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA)); Regan, P.; Ninesteel, R.; Martin, R. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 3.* Order Number DE89014702/JAW. Available from NTIS, PC A14/MF A01.

Kelly Air Force Base (AFB), which was founded in 1917, is involved in logistics and maintenance activities supporting the Air Logistics Command. In addition, Kelly AFB hosts over 50 tenant organizations representing the Air Force, Department of Defense, and other government agencies. Over the years waste disposal from

this complex was conducted in a manner that led to the identification of over 30 sites to be included in the Installation Restoration Program (IRP) after the Phase 1 investigation. A methodology was needed to prioritize the Remedial Investigations and Feasibility Study (RI/FS) activities for the sites. A Strategy Plan was developed that involved reviewing and interpreting existing data, identifying data voids relative to site specific RI/FS activities, and developing methodology to prioritize activities. Sites were prioritized, and a comprehensive IRP planning document was developed. One data deficiency was revealed - the lack of understanding of the Basewide hydrogeologic conditions necessary to establish an effective restoration program. A Hydrogeologic Investigation was initiated to provide this data. This data will allow better interpretation of the interaction of the sites, particularly those in close proximity, and improved planning of remediation activities.

47219 (CONF-881054–Vol.3, pp. 933-944) **DOT/OSHA/EPA (Department of Transportation/Occupational Safety and Health Administration/Environmental Protection Agency) integrated DOE (Department of Energy) transportation training.** Stancell, D.F. (Science Applications International Corp., Oak Ridge, TN (USA)); Carnes, N. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 3.* Order Number DE89014702/JAW. Available from NTIS, PC A14/MF A01.

Recent legislative, regulatory and judicial developments affecting transportation of hazardous materials require a new approach to regulatory compliance training which integrates the requirements of several statutes and sets of regulations. These developments include the Superfund Amendments and Reauthorization Act of 1986 (SARA) requirement that DOT (Department of Transportation) regulate as hazardous materials all substances designated as hazardous pursuant to the Comprehensive, Environmental Response, Compensation and Liability Act (CERCLA); the reporting requirements of the Emergency Planning and Community Right-to-Know Act; the Hazardous Waste Operations and Emergency Response provision of SARA sec. 126; the expansion of the OSHA (Occupational Safety and Health Administration) hazard communication standard to all sectors of employment; and the increased EPA (Environmental Protection Agency)-DOT enforcement of the RCRA (Resource Conservation and Recovery Act) hazardous waste regulations. This paper will describe a training course developed for DOE in the requirements of DOT, OSHA and EPA pertaining to the transportation of hazardous materials, substances, and wastes. The paper will discuss the methodology and approach used to integrate and explicate the overlapping legal requirements and the problems encountered with such an approach.

47220 (CONF-881054–Vol.4, pp. 1331-1344) **Use of a Monte Carlo modeling approach for evaluating risk and environmental compliance.** Higley, K.A. (Pacific Northwest Lab., Richland, WA (USA)); Strenge, D.L. Analysas Corp., Oak Ridge, TN (USA). 1988. DOE Contract AC06-76RL01830. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

Evaluating compliance with environmental regulations, specifically those regulations that pertain to human exposure, can be a difficult task. Historically, maximum individual or worst-case exposures have been calculated as a basis for evaluating risk or compliance with such regulations. However, these calculations may significantly overestimate exposure and may not provide a clear understanding of the uncertainty in the analysis. The use of Monte Carlo modeling techniques can provide a better understanding of the potential range of exposures and the likelihood of high (worst-case) exposures. This paper compares the results of standard exposure estimation techniques with the Monte Carlo modeling approach. The authors discuss the potential application of this approach for demonstrating regulatory compliance, along with the strengths and weaknesses of the approach. Suggestions on implementing this method as a routine tool in exposure and risk analyses are also presented.

47221 (CONF-881054–Vol.4, pp. 1347-1358) **Lightning safe environment for hazardous materials.** Carpenter, R.B. Jr. Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

Lightning and the related secondary effects present a significant hazard to those who handle some forms of hazardous materials. In this paper, the methods of lightning protection are discussed.

47222 (CONF-881054–Vol.5, pp. 1449-1459) **Complex environmental requirements compel logical approach: The CERCLA Comprehensive Environmental Response, Compensation, and Liability Act) framework at Fernald.** Yeasted, J.G. (IT Corp., Torrance, CA (USA)); Carr, D.J.; Conner, C.R.; Wilde, R.T. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 5.* Order Number DE89014704/JAW. Available from NTIS, PC A13/MF A01.

Routine environmental compliance activities continue to be aggressively pursued at the US Department of Energy's (DOE's) Feed Materials Production Center (FMPC) at Fernald, Ohio. In addition, however, both active and inactive operations at the FMPC must achieve compliance with the special environmental requirements of a Federal Facility Compliance Agreement (FFCA) entered into with the US Environmental Protection Agency (US EPA), Director's Findings and Orders of the State of Ohio, and specific requests from Congressional entities. In order to achieve a consistency of effort and a focused goal within this complex environmental compliance setting, critical interrelationships of 32 separate study elements were put on a common investigative basis by adopting the source-pathway-receptor framework of a Remedial Investigation and Feasibility Study (RI/FS) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). A second type of integrated framework further reduced the site complexities to an easily understood (and justifiable) statement of the investigative needs. This framework utilized a dual matrix for each of the identified sources, pathways, and receptors to integrate the potential remedial actions, related informational needs to perform an assessment of the actions, and proposed investigative tasks to satisfy the informational needs. The Work Plan for the sitewide RI/FS at the FMPC provided for a sampling and analysis program consistent with the need to produce data for the evaluation of remedial alternatives in the FS. However, the existing data base on some facilities and media was so limited that a phased RI approach became necessary both to achieve cost-effectiveness and to better focus resources in subsequent investigations. The RI/FS Work Plan also provided for a single, multiyear application of the FS process.

47223 (CONF-881054–Vol.5, pp. 1517-1528) **Preliminary results of the immobilization of highly-salt-ladened concentrate in cement-based grout: A joint DOE/CEA (Department of Energy/Commissariat a l'Energie Atomique) research effort.** Bouniol, P.E. (Commissariat a l'Energie Atomique, Saclay (France)); Peyre, C.H.; Mattus, A.J.; Pitt, W.W. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 5.* Order Number DE89014704/JAW. Available from NTIS, PC A13/MF A01.

The ability of two types of cement-based matrices to immobilize highly-salt-ladened concentrate containing primarily nitrate and phosphate is examined when considering both fresh and hardened material properties. The effects of the incorporation ratio and the temperature of the feed concentrate are evaluated.

47224 (CONF-881054–Vol.5, pp. 1669-1689) **Isolation and identification of microorganisms capable of degrading common laboratory solvents.** Chapatwala, K.D. (Selma Univ., AL (USA)); Wolfram, J.H. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 5.* Order Number DE89014704/JAW. Available from NTIS, PC A13/MF A01.

The disposal of toxic organic compounds is becoming more difficult and more costly as restrictions and limitations are increased.

Educational institutions are no exception to this situation. Universities, Hospitals and other research laboratories generate small quantities of a variety of common organic solvents and compounds which presently require special disposal requirements. Most of these solvents and chemicals are small molecular weight compounds that are not complex. The work the authors have been doing is to isolate microbial cells that have the capability to degrade common laboratory solvents. The initial work focused on solvents with differing functional groups, e.g. acetonitrile, toluene, chloroform, hexane, ethyl acetate, diethyl ether, etc. The findings thus far support the concept that bioprocessing of organic solvents offers an alternative, on-site disposal treatment technology.

47225 (MHWMC–8808) **The development of a hazardous waste management system in Manitoba.** Manitoba Hazardous Waste Management Corp., Winnipeg, MB (Canada). 1988. 56p. (MICROLOG–89-02979). Available from Manitoba Hazardous Waste Management Corporation, 226-530 Century Street, Winnipeg, MB, CAN R3H 0Y4; PRICES UPON REQUEST, FUNDS CAN; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1; $10 CAN.

This paper is intended to provide an overview of the subject of hazardous waste and to describe the progress toward the development of a comprehensive system for its management in Manitoba. In addition, it discusses a number of issues which are fundamental to this development: types and quantities of wastes, public awareness, absence of regulation, lack of appropriate treatment and disposal alternatives, and economic impediments. The subject of hazardous waste as an environmental and social issue is introduced. The history of interest in the subject is summarized with specific reference to experience in Europe, the USA and elsewhere in Canada. This is followed by a more detailed description of what has occurred in Manitoba and the role currently assumed by the Manitoba Hazardous Waste Management Corporation. It concludes with the discussion of a number of current public policy issues relating to the development of a hazardous waste management system in Manitoba: public acceptance, the need for a system, economic viability, business structure, and market scope. 48refs., 6 figs., 4 tabs.

47226 (PB–89-174239/XAB) **Toxic chemical report, first annual: a summary of information contained in the toxic chemical report forms for calendar year 1987. Final report.** Carlson, R.L.; Lampe, J.A.; Goodner, J.F. Illinois Environmental Protection Agency, Springfield, IL (USA). Environmental Programs. Feb 1989. 158p. (IEPA/ENV–89-012). Available from NTIS, PC A08/MF A01.

This report summarizes the information contained in the Toxic Chemical Release Inventory Reporting Forms (Form R) for calendar year 1987 as submitted to the Illinois Environmental Protection Agency. The information includes all routine and non-routine releases of toxic chemicals in Illinois to the air, water, and land, as well as transfers of wastes to offsite treatment storage and disposal facilities. Title III, Section 313 of the Superfund Amendments and Reauthorization Act of 1986 (SARA) requires Form Rs to be filed by certain companies that release any of the listed toxic chemicals to the environment.

47227 (PB–89-188536/XAB) **Integrated environmental management: A need for change. Technical report.** Shannon, D. Colorado Univ., Boulder, CO (USA). Jan 1989. 43p. Available from NTIS, PC A03/MF A01.

Integrated environmental management means implementing environmental laws in a concerted fashion, such that one approaches environmental problems in a holistic manner. The author reports the degree of implementation of laws and examines the obstacles blocking the way to an integrated system and what can be done to overcome these problems. A detailed evaluation of all the obstacles and problems is not made here, but such a study can be built from recommendations and conclusions in the report. The study will be important to environmental engineers and scientists working in regulatory agencies and in industry to provide a broad picture of different laws and illustrate the application of these laws to a case study: the Syntex Chemicals, Inc. facility. Additionally, the assessment of how the laws are integrated and what integration initiatives have worked and which have not should be considered by the EPA in its efforts to streamline and improve its organization and procedures.

47228 (PB–89-188551/XAB) **Local implementation by New England municipalities of the Emergency Planning and Community Right-To-Know Act of 1986 (Title 3 of SARA) (Superfund Amendments and Reauthorization Act). Technical report (Final).** Church, Z. Harvard Univ., Cambridge, MA (USA). John Fitzgerald Kennedy School of Government. 1988. 42p. Available from NTIS, PC A03/MF A01.

Portions of this document are not fully legible.

This report, based on 16 interviews with 16 Local Emergency Planning Committee (LEPC) Chairs and other officials in New England communities, assesses the implementation of Title III of the Superfund Amendments and Reauthorization Act (SARA) at the local level. The local emergency planning districts surveyed for the report, selected primarily from the EPA's 'Priority Planning Districts,' represent every major type of community. Topics covered by the report include the scope of emergency planning, public and industrial participation, and the role of the EPA.

47229 (PB–89-189567/XAB) **Approaches to risk training: An evaluation of EPA (Environmental Protection Agency) risk training materials. Technical report.** Crook, A.E. North Carolina Univ., Chapel Hill, NC (USA). 1988. 567p. Available from NTIS, PC A24/MF A01.

Portions of this document are not fully legible.

This report is part of the National Network for Environmental Management Studies under the auspices of the Agencywide Technology Transfer Staff of the U.S. Environmental Protection Agency. The study determines the best approaches for educating the public, environmental health professionals, and environmental managers in the risk assessment/risk management process for drinking water contamination. The report reviews the risk training materials published by the EPA. Because the project focuses on risk assessment and management with respect to drinking water contamination, the report concentrates on a workshop presented by the Office of Drinking Water in August of 1988: Workshops on Assessment and Management of Drinking Water Contamination. The report also presents the results of a survey of state public health/environmental agencies with jurisdiction over drinking water. Two questions were asked: do they conduct or participate in risk training programs or have written risk policy documents; and what are the major drinking water contamination concerns in their state. The report is divided into five sections: Approach to Evaluation of EPA Materials; ODW Workshop on Assessment and Management of Drinking Water Contamination; EPA Risk Training Material; EPA Risk Policy/Guidelines; and Survey of State Agencies.

47230 (PB–89-189641/XAB) **Risk-assessment management, communication: a guide to selected sources. Volume 2, Number 2. Information guide.** Environmental Protection Agency, Washington, DC (USA). Office of Information Resources Management. Oct 1988. 83p. (EPA/IMSD–88/002B). Available from NTIS, PC A05/MF A01.

See also PB–88-210596.

This document is the sixth update in EPA's series of risk-management bibliographies. References were gathered from the environmental, medical and scientific literature included in the following data bases: Medline, Conference Papers Index, Enviroline, NTIS, PAIS Public Affairs Information Service, ABI Inform, and Legal Resource Index. The citations cover documents added to those collections during the period from March 1988 through August 1988. The original Guide appeared in March 1987 and was followed by quarterly updates. These earlier updates constitute volume one of the current semiannual series. The document is subdivided into Risk Assessment, Risk Management and Risk Communication. The Table of Contents lists further divisions of each of these categories. Citations are arranged alphabetically by title, with the exception of the chemical specific references. These citations are grouped alphabetically by chemical name. Abstracts in the Risk Assessment section have been shortened or eliminated if the content of the article is adequately reflected in the title.

47231 (PB–89-189716/XAB) **EPA's (Environmental Protection Agency) role in non-hazardous solid-waste management on Indian land: issues and options. Technical report.** Ruff, M. Minnesota Univ., Minneapolis, MN (USA). Hubert H. Humphrey Inst. of Public Affairs. 1988. 33p. Available from NTIS, PC A03/MF A01.

Non-hazardous solid-waste management is a serious and persistent issue for Indian lands which encompass 87,000 square miles and include the county's 280 Indian reservations as well as approximately 200 Alaska native villages. EPA's role has been, and remains, indirect because the management and regulation of non-hazardous solid waste is predominantly the responsibility of State and local governments. The Resource Conservation and Recovery Act (RCRA) includes Indian Tribes and Alaska native villages in the definition of municipalities while federal legislation and federal case law affirms the right of tribes to self-determination. Including Tribes under the definition of municipalities results in a 'gap' in RCRA. The paper examines the problem of non-hazardous solid-waste on Indian lands and attempts to establish the extent of the problem. It outlines the current roles of federal agencies involved in the issue, presents three regulatory and legislative options, and recommends the option which best enables the EPA to effectively aid the tribes in the management of non-hazardous waste on Indian lands.

47232 (PB–89-194526/XAB) **Multi-media compliance audit procedures, 1989. Final report.** National Enforcement Investigations Center, Denver, CO (USA). Mar 1989. 356p. (EPA–330/9-89/003-R). Available from NTIS, PC A16/MF A01.

Supersedes PB–88-114053.

This manual is intended as a guide for investigators who conduct multi-media compliance audits of facilities that discharge, emit, prepare, manage, store, or dispose of substances controlled by federal, state or local environmental laws and regulations. Investigative methods are presented that integrate the enforcement programs associated with air, water, solid waste, pesticides, and toxic substances. Investigators performing compliance audits follow established policies and procedures for: (1) chain-of-custody and document control; (2) handling of confidential information; (3) employee conduct; (4) quality assurance and quality control; and (5) safety rules.

2904 Natural Resources

Refer also to citation(s) 47212, 48050, 48052

47233 (PB–89-160584/XAB) **Refrigeration for food and people: an essential technology for the welfare of man.** Lorentzen, G. SINTEF, Trondheim (Norway). 27 May 1988. 15p. (STF–11-A88056). Available from NTIS, PC EE03/MF E03.

The yearly investment in refrigeration machinery is estimated at nearly 100 billion US$. It is essential in solving two major problems of the future: The supply of enough food and the development of new energy sources. Various problems and possibilities in this context are discussed.

47234 (PB–89-206981/XAB) **Habitat requirements for Chesapeake Bay living resources. Chesapeake Bay Program Agreement Commitment Report.** Environmental Protection Agency, Annapolis, MD (USA). Chesapeake Bay Program. Jan 1988. 127p. Available from NTIS, PC A07/MF A01.

See also PB–88-142831.

This report provides guidance, along with EPA Water Quality Criteria and State Water Quality Standards and other information, to help refine and improve Chesapeake Bay Agreement programs designed to provide for the restoration and protection of living resources, their habitats, and ecological relationships. The Living Resources Task Force, an ad hoc workgroup of the Chesapeake Bay Program, was charged by the Chesapeake Bay Implementation Committee to develop an approach to define habitat objectives for the living resources of the Bay. The report was produced by the Task Force to establish a technically defensible approach in setting regional habitat objectives for Chesapeake Bay by initially assembling habitat requirement for individual target species. It summarizes the results of the Task Force efforts to date and provides the basis for future refinement of the habitat objectives approach.

47235 (SEMR–8803) **Saskatchewan Energy and Mines annual report, 1987-88.** Saskatchewan Dept. of Energy and Mines, Regina, SK (Canada). 1988. 31p. (MICROLOG–89-03890). Available from Saskatchewan Energy and Mines, 1914 Hamilton St., Regina, Sask., CAN S4P 4V4; $N/C; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1; $10 CAN.

This report summarizes the activities and policies of the Saskatchewan Energy and Mines and its divisions of Finance and Administration, Resource Policy and Economics, Geology and Mines, and Petroleum and Natural Gas. Policy objectives of the divisions are described and include research and analysis of policy issues related to energy and resource development, promotion of exploration and development activities in the petroleum and mineral sectors, disposition and management of provincial oil and gas rights, well licensing, surveillance of oil and gas industry operations, oil and gas conservation, maintenance of statistics on reserves, production, and disposition of oil and gas, crude oil marketing, and royalty and tax legislation. Production and financial statistics are included where applicable, and publications of the particular sections, if any, are listed. 18 figs., 1 tab.

2905 Research, Development, Demonstration, and Commercialization

Refer also to citation(s) 46791, 46795, 46796, 46797, 46798, 46799, 47036, 47040, 47210, 47211, 47229, 47233, 47254, 47323, 47460, 47714, 48092

47236 (DOE/CE/10509–H1) **Demand-side management federal program directory.** Meridian Corp., Alexandria, VA (USA). Nov 1988. 7p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC01-85CE10509. Order Number DE89016063/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A directory and brief program descriptions of the following are provided in this report: Argonne National Laboratory; Bonneville Power Administration; Brookhaven National Laboratory; Lawrence Berkeley Laboratory; Solar Energy Research Institute; Southwest Area Power Administration; Tennessee Valley Authority; Institutional Conservation Programs; Office of Policy Integration; Residential and Commercial Conservation Branch; and the Western Area Power Administration. (CBS)

47237 (DOE/CH/00016–H2) **Analysis and technology transfer: Annual report 1988: Buildings and Community Systems.** Brookhaven National Lab., Upton, NY (USA). May 1989. 145p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC02-76CH00016. Order Number DE89016923/JAW. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

The US Department of Energy (DOE) Office of Buildings and Community Systems (BCS) encourages increased efficiency of energy use in the buildings sector through the conduct of a comprehensive research program, the transfer of research results to industry, and the implementation of DOE's statutory responsibilities in the buildings area. The planning and direction of these activities require the development and maintenance of database and modeling capability, as well as the conduct of analyses. This report summarized the results of analytical and technology transfer activities undertaken on behalf of BCS during 1988. It provides historical data on energy consumption patterns, prices, and building characteristics used in BCS's planning processes, documents BCS's detailed projections of energy use by end use and building type (the Disaggregate Projection), and compares this forecast to other forecasts. Summaries of selected recent BCS analyses and technology transfer activities are also provided. 32 refs.

47238 (DOE/ER–0144/7) **Summaries of FY 1989 research in the chemical sciences.** USDOE Office of Energy Research, Washington, DC (USA). Chemical Sciences Div.; USDOE Office of Scientific and Technical Information, Oak Ridge, TN (USA). Aug 1989. 142p. Sponsored by U.S. DOE Energy Research. Order Number DE89010902/JAW. Available from NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.

These summaries provide the scientific and technical public, as well as the legislative and executive branches of the Government, information, either generally or in some depth, about the Chemical Sciences program. Areas of research supported are indicated in the section headings, the "Selected Topics of General Interest" list, and

the summaries themselves. Energy technologies that may be advanced by use of the basic knowledge generated in this program are included in the "Selected Topics of General Interest" list and are often referenced in the summaries.

47239 (EMR/ER–86-33(TR)) **Contract R&D technically administered by the Energy Research Laboratories. FY 1985/86.** Skubnik, M. Canada Centre for Mineral and Energy Technology, Ottawa, ON (Canada). Energy Research Labs. 1986. 37p. (MICROLOG–87-03257). Available from CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. $3.40 CAN minimum, plus $0.25/p after 10 pages; MF $10 CAN.

In 1985/86, Canada's Energy Research Laboratories (ERL) continued in-house research on conversion and utilization of fossil fuels as well as upgrading of synthetic fuels. To a lesser extent ERL was also involved in energy conservation and utilization of biomass for heating. This report defines the scope of ERL's activities and summarizes the 1985/86 research and development contracts. Financial expenditures and benefits are also presented. It is seen that in 1985/86 ERL developed and administered 161 contracts and 4 financial contributions towards R&D programs. The contract value including fiancial contributions was $19,030,600 at an average value of $115,300. Of these contracts 58 were initiated by ERL staff, 11 were awarded through unsolicited proposals received from Supply and Services Canada, and 12 were awarded under the Canada Centre for Mineral and Energy Technology 50/50 Energy Conversion Program. The other 80 contracts were continued from 1984/85. About 44%, were or will be awarded to private companies, 28% to para-public organizations and 28% to Canadian universities. Sixty-six final reports, 34 journal publications, 30 conference presentations, 1 CANMET report and 8 patent applications were generated from these contract investigations. 7 tabs

47240 (KURRI-TR–310) **Development of advanced technology for scientific research.** Okamoto, Sunao (ed.). Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. Dec 1988. 3p. (In Japanese). (CONF-8809395–: Workshop on development of advanced technology for scientific research, Kumatori (Japan), 12-13 Sep 1988). Order Number DE89018006/JAW. Available from NTIS (US Sales Only), PC A04/MF A01.

A workshop on the development of advanced technology for scientific research was held at Kumatori, Osaka, Japan during 12-13th of September 1988. Papers have been processed individually for the data bases. (DLC)

47241 (NAS–9016558) **The Government-University-Industry Research Roundtable: 1988 annual report.** Government-University-Industry Research Roundtable, Washington, DC (USA). Jan 1989. 19p. Sponsored by National Academy of Sciences/National Academy of Engineering/Institute of Medicine. Order Number DE89016558/JAW. Available from NTIS, PC A03/MF A01 - OSTI.

The Government-University-Industry Research Roundtable was created to provide a forum where scientists, engineers, administrators, and policy makers from government, universities, and industry can come together on an ongoing basis to explore ways to improve the productivity of the nation's research enterprise. The object is to try to understand issues, to inject imaginative thought into the system, and to provide a setting for seeking common ground. The Roundtable does not make recommendations, nor offer specific advice. It develops options and brings all interested parties together. The uniqueness of the Roundtable is in the breadth of its membership and in the continuity with which it can address issues. The Roundtable is sponsored by the National Academies of Sciences and Engineering and the Institute of Medicine.

47242 (ORNL–6540/V1) **Energy Division annual progress report for period ending September 30, 1988: Volume 1.** Oak Ridge National Lab., TN (USA). Jun 1989. 85p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89015685/JAW. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The goals and accomplishments of the Energy Division of Oak Ridge National Laboratory are described in this annual progress report for Fiscal Year (FY) 1988. The Energy Division is a multidisciplinary research organization committed to (1) increasing the knowledge and understanding of the way society makes choices in energy use and energy-using technologies, (2) improving society's understanding of the environmental implications of changes in energy technology, and (3) improving and developing new energy-efficient technologies. The Energy Division's programmatic activities focus on four major areas: (1) analysis and assessment, (2) transportation and decision systems research, (3) technology research and development for improving the efficiency of energy end-use technologies, and (4) electric power systems. The Division's total expenditures in FY 1988 were $44.3 million. The work is supported by the US Department of Energy, US Department of Defense, many other federal agencies, and some private organizations. Disciplines of the 139 staff members include engineering, social sciences, physical and life sciences, and mathematics and statistics.

47243 (ORNL/M–772) **Technology applications bulletins: Number one.** Koncinski, W. Jr. (ed.). Oak Ridge National Lab., TN (USA). Feb 1989. 74p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017454/JAW. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

Martin Marietta Energy Systems, Inc. (Energy Systems), operates five facilities for the US Department of Energy (DOE): the Oak Ridge National Laboratory (ORNL), which is a large, multidisciplinary research and development (R and D) center whose primary mission is energy research; the Oak Ridge Y-12 Plant, which engages in defense research, development, and production; and the uranium-enrichment plants at Oak Ridge; Paducah, Kentucky; and Portsmouth, Ohio. Much of the research carried out at these facilities is of interest to industry and to state or local governments. To make information about this research available, the Energy Systems Office of Technology Applications publishes brief descriptions of selected technologies and reports. These technology applications bulletins describe the new technology and inform the reader about how to obtain further information, gain access to technical resources, and initiate direct contact with Energy Systems researchers.

47244 (PUR–9016435) **[School of Electrical Engineering of Purdue University]: Annual research summary, July 1, 1988–June 30, 1989.** Purdue Univ., Lafayette, IN (USA). School of Electrical Engineering. 1989. 245p. Sponsored by Purdue University. Available from OSTI; Purdue University, School of Engineering, West Lafayette, IN 47907.

This document summarizes the research activities within the School of Electrical Engineering of Purdue University. It is intended as a reference document for colleagues, prospective graduate students and organizations interested in electrical engineering research. The research activities of Part I are organized according to ten areas. The first eight of these are areas in which the Purdue Electrical Engineering graduate program is divided for administrative purposes. The ten areas are: automatic controls; electromagnetic fields; bioengineering; energy source and systems; circuit theory; solid state devices and materials; communications and signal processing; engineering education; and computer engineering.

47245 (UCRL–53929-88) **Nuclear Test-Experimental Science: Annual report, fiscal year 1988.** Struble, G.L.; Donohue, M.L.; Bucciarelli, G.; Hymer, J.D.; Kirvel, R.D.; Middleton, C.; Prono, J.; Reid, S.; Strack, B. (eds.). Lawrence Livermore National Lab., CA (USA). 1988. 277p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE89016960/JAW. Available from NTIS, PC A13/MF A01; OSTI; INIS; GPO Dep.

Fiscal year 1988 has been a significant, rewarding, and exciting period for Lawrence Livermore National Laboratory's nuclear testing program. It was significant in that the Laboratory's new director chose to focus strongly on the program's activities and to commit to a revitalized emphasis on testing and the experimental science that underlies it. It was rewarding in that revolutionary new measurement techniques were fielded on recent important and highly complicated underground nuclear tests with truly incredible results. And it was exciting in that the sophisticated and fundamental problems of weapons science that are now being addressed experimentally are yielding new challenges and understanding in ways that stimulate and reward the brightest and best of scientists.

During FY88 the program was reorganized to emphasize our commitment to experimental science. The name of the program was changed to reflect this commitment, becoming the Nuclear Test-Experimental Science (NTES) Program.

2906 Nuclear Energy

Refer also to citation(s) 47159, 47160, 48699, 48753

47246 (DOE/OR/21400–T394) **Conversion of NE [nuclear energy] standards to national consensus standards.** Jennings, S.D.; Hudson, R.C. Oak Ridge National Lab., TN (USA). Performance Assurance Project Office. Jul 1989. 9p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE89017333/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report is a summary of the activities that have evolved to effect conversion of nuclear energy standards to national consensus standards, and the status of current conversion activities. (JF)

47247 (LA-UR–89-2713) **Role of IAEA [International Atomic Energy Agency] safeguards in confidence building.** Augustson, R.H. Los Alamos National Lab., NM (USA). [1989]. 5p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-8907103–6: Technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). Order Number DE89016999/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In this paper, I will examine some attributes of confidence building and connect them with how the International Atomic Energy Agency (IAEA) interacts with its member states in carrying out its safeguards function. These interactions and the structure set up to define them help maintain and strengthen confidence between the IAEA and the member states and among these states. 3 refs.

2908 Waste Heat Utilization

Refer also to citation(s) 47255

2910 Conservation

Refer also to citation(s) 46908, 46917, 47273, 47278

2920 Supply, Demand, and Forecasting

47248 (AD-A–205673/7/XAB) **Energy forecasting and analysis system for the US Army Materiel Command. Final report.** Binder, M.J. Army Construction Engineering Research Lab., Champaign, IL (USA). Feb 1989. 30p. (CERL-TR-E–89/07). Available from NTIS, PC A03/MF A01.

The Army has been assigned energy-reduction goals with a base year of FY85 and a target year of FY95. In the interim, energy managers are required to assess the effectiveness of energy-conservation efforts in terms of progress toward attaining these goals. Direct comparison of current and base fiscal year energy-consumption data is not a satisfactory method for evaluating energy-conservation measures, as the effectiveness of these efforts may easily appear enhanced or diminished due to differences in weather and level of production between the current and base fiscal years. For a realistic assessment, energy managers need a mathematically sound methodology to filter out the effects caused by year-to-year differences in weather and production levels.

47249 (PB–89-193981/XAB) **GRI (Gas Research Institute) baseline projection methodology and assumptions. Topical report. Revised.** Blanford, K.M. DRI Energy Div./McGraw-Hill Financial Services Co., Lexington, MA (USA). Dec 1988. 139p. Available from NTIS, PC A07/MF A01.

See also PB–89-173264 and PB–89-193999.

The GRI annual baseline projection of U.S. energy supply and demand provides a consistent framework of data which is used in planning GRI's R&D program. The report discusses the forecasting assumptions and model methodology used in generating the 1988 baseline projection. Included is an explanation of the DRI energy modeling system, which employs seven models. The energy demand analysis for the residential, industrial, commercial, transportation, and electric-utility sectors of the economy are described, and the supply side analysis for natural gas, oil, coal, electricity, and renewable fuels is explained. Enhancements made to the 1988 GRI Baseline Projection methodology are also described.

47250 (PB–89-193999/XAB) **GRI (Gas Research Institute) baseline projection regional summary. Topical report, January 1989.** Dalbeck, B.W.; Papke, J.B.; Blanford, K.M. DRI/McGraw-Hill Energy Service, Lexington, MA (USA). 1989. 332p. Available from NTIS, PC A15/MF A01.

See also PB–89-193981.

The GRI annual baseline projection of U.S. energy supply and demand provides a consistent framework of data which is used in planning GRI's R&D program. The report includes summary data for the eleven regions of the United States used in the GRI/DRI energy modeling system. A macroeconomic summary, a regional energy summary, and supply and demand data for the residential, commercial, industrial, and electric-utility sectors are provided for each region.

2930 Policy, Legislation, and Regulation

Refer also to citation(s) 47148, 47212, 47225

47251 (UR/CPRC–1989) **Free trade on the prairies. The implications of the Canada-U.S. trade pact for the three prairie provincec.** Dorey, S. Regina Univ., SK (Canada). Canadian Plains Research Center. 1989. 146p. (MICROLOG–89-02713). Available from Canadian Plains Research Centre, University of Regina, Regina, SK, CAN S4S 0A2; PRICES UPON REQUEST, FUNDS CAN; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1; $10 CAN.

The west has historically viewed protection in Canada as a device designed to transfer wealth generated by world-class resource exporters competing freely in world markets to eastern manufacturers who had neither the ability nor the inclination to compete in open international markets. Free trade, it was maintained, would ensure prosperity for the west as the country turned to producing resource-based products for world markets. However, over the past 2 years, opinion polls indicate that there is no consenus on the Prairies concerning the desirability of bilateral free trade with the United States, but rather a diversity of expectations and concerns. This study considers briefly those developments which have compromised this faith in free trade, then examines the expected effects of both free trade in general and the Canada-US Free Trade Agreement reached on October 4, 1987, on various sectors (agriculture, energy and natural resources, manufacturing, services, and investment) and particularly on individual industries to the Prairies. The study also considers the sectoral and regional implications of various economic models concerning liberalization, and the macroeconnomic effects of free trade and their consequences for the Prairie region. The study concludes that the Praire and world economics have evolved over the past several decades in ways that remove much of the attraction of bilateral free trade for the Prairie provinces; that the Canada-USA Free Trade Agreement is likely to meet few of the needs of the Prairie industries; and that inherent in the Agreement are significant risks for the future development of the region. 253 refs., 4 figs., 5 tabs.

2940 Fossil Fuels

Refer also to citation(s) 46795, 46796, 46797, 46798, 46799, 46904, 46908, 46909, 46910, 46924, 47235, 47239, 47255

47252 (DOE/FE–0116-2) **Strategic Petroleum Reserve quarterly report.** USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA). Office of Petroleum Reserves. 15 Aug 1989. 11p. Sponsored by U.S. DOE Fossil Energy. Order Number DE89016713/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This August 15, 1989, Strategic Petroleum Reserve Quarterly Report describes activities related to the site development, oil acquisition, budget and cost of the Reserve during the period April 1, 1989 through June 30, 1989.

47253 (ETDE-mf–0702776) **MMV figures on petroleum 1988.** Mineraloelwirtschaftsverband e.V., Hamburg (Germany, F.R.). 1989. 52p. (In German). Order Number DE90702776/JAW. Available from NTIS (US Sales Only), PC A04/MF A01.

Tables are presented containing the most important figures of the petroleum industry worldwide, in Europe, and in West Germany. Subjects: Capacities, petroleum supply, petroleum consumption, petroleum exports, petroleum prices, energy consumption, world petroleum figures. (UA).

47254 (SOQUIP–1988) **SOQUIP. Annual report, 1987-1988.** SOQUIP, Quebec, PQ (Canada). [1989]. 26p. (In French). (CONF-890901–: 14. world energy conference, Montreal (Canada), 17-22 Sep 1989; MICROLOG–88-05907). Available from SOQUIP (Societe quebecoise d'initiatives petrolieres), 1175, rue de Lavigerie, C.P. 10650, Ste-Foy, PQ, Canada G1V 4P5; $N/C; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1; $10 CAN.

SOQUIP is a Quebec government corporation whose activities include oil and gas exploration and production, energy supply, natural gas distribution, and energy research and development. This report reviews the activities over the year of SOQUIP and its subsidiaries, including SOQUIP Alberta, SOQUIP Atlantique, the Soligaz Project, and Noverco. Highlights of recent developments are the sale of SOQUIP Alberta assets in exchange for a 14% interest in Sceptre Resources, and completion of the first phase of a project to transport natural gas liquids to Montreal. Production and consumption information, and financial statements, are also included.

2950 Hydrogen and Synthetic Fuels

Refer also to citation(s) 47239

2960 Electric Power

47255 (ETDE-mf–0702694) **The influence of the pricing of networked energy carriers on the efficient use of energy in Hesse. Final report.** Studien zur Energiepolitik in Hessen. Brand, M.; Gruber, E.; Jochem, E.; Mannsbart, W.; Meyer, T.; Witt. B.; Euringer, P.; Gruending, F.J.; Kalb, H.; Poppke, H. Fraunhofer-Institut fuer Systemtechnik und Innovationsforschung (ISI), Karlsruhe (Germany, F.R.); Hessisches Ministerium fuer Wirtschaft und Technik, Wiesbaden (Germany, F.R.). Sep 1988. 326p. (In German). Contract ISI 104612. Order Number DE90702694/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

The networked energy carriers electricity, gas and district heating have been increasing their share in energy consumption world-wide, in the Federal Republic they have been doing so for decades now. The reason for this is that the networked energy carriers are very versatile. All of the useful energy forms can be supplied with electrical energy and the majority of them with gas, while other energy carriers e.g. petroleum products or coal cannot be used for some purposes or only at higher cost and with considerable deployment of personnel. The following study objectives arise out of the current problems of pricing of networked energy carriers: The economic viability of energy-saving measures is to be calculated with different price structures for networked energy carriers using typical cases of energy consumption for conditions in Hesse. The effects of various price structures for networked energy carriers on the energy consumption of affected energy consumer groups in Hesse are to be estimated, taking into consideration experiences from abroad. The effects of time-variable electricity tariffs on typical load lines are to be discussed on the basis of international experiences. Since the effects of various price structures for networked energy carriers on the profit situation of the EVU and on the energy costs of individual consumer groups are in part controversial, more insight must be gained in these points, before the supply industry can switch to new tariff and price structures. (orig./UA).

47256 (PB–89-202758/XAB) **Bibliography of the Maryland Power Plant and Environmental Review Division, tenth edition.** Magette, T. Maryland Power Plant Research Program, Annapolis, MD (USA). Apr 1989. 69p. (PPRP-B–10). Available from NTIS, PC A04/MF A01.

See also PB–86-227626.

The Power Plant Siting Act of 1971 (Sec. 3-303) established the Power Plant Research Program (formerly the Power Plant Siting Program) to insure that demands for electric power would be met in a timely manner at a reasonable cost while assuring that the associated environmental impacts would be acceptable. The scope of the Program extends to estimating the impact of proposed new generating facilities, evaluating the acceptability of proposed transmission line routes, assessing the impact of existing generating facilities, acquiring sites for utilities unable to find a suitable site for generation, and investigating generic issues related to power-plant site evaluation and associated environmental and land-use considerations. The bibliography is a compilation of all the studies performed for and/or by the Power Plant Research Program since its inception.

2980 Consumption and Utilization

Refer also to citation(s) 47209, 47288

2990 Unconventional Sources and Power Generation

Refer also to citation(s) 47026, 47067

30 DIRECT ENERGY CONVERSION

Refer also to citation(s) 47203

3001 MHD Generators

47257 (DOE/PC/79680–T1) **Computer controlled MHD power consolidation and pulse-generation system: Progress report, October 1987–March 1988.** Johnson, R. Montana State Univ., Bozeman, MT (USA). Dept. of Electrical Engineering. 1989. 53p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-87PC79680. Order Number DE89015600/JAW. Available from NTIS, PC A04/MF A01 - OSTI.

The major goal of this project is to establish the feasibility of a power conversion technology which will permit the direct synthesis of computer programmable pulse power. Feasibility will be established in this project by demonstration of direct synthesis of commercial frequency power by means of computer control. The power input to the conversion system is assumed to be a MHD Faraday connected generator which may be viewed as a multiterminal d.c. source. This consolidation/inversion process is referred to subsequently as Pulse- Amplitude-Synthesis-and-Control (PASC). A secondary goal is to deliver a controller subsystem consisting of a computer, software, and computer interface board which can serve as one of the building blocks for a possible Phase II prototype system. This report covers the initial six months portion of the project and includes discussions on the following areas: (1) selection of a control computer with software tool kit for development of the PASC controller contract requirement; (2) problem formulation considerations for simulation of the PASC technique on digital computers; (3) initial simulation results for the PASC transformer, including simulation results obtained using SPICE and the INTEG program; (4) a survey of available gate-turn-off (GTO's), power semiconductors, power field effect transistors (PFET's), and fiber optics signal cabling and transducers. 2 refs., 14 figs.

47258 (DOE/PC/90274–T5) **MHD (Magnetohydrodynamics) Integrated Topping Cycle: Sixth quarterly progress report, November 1, 1988–January 31, 1989.** TRW Space and Technology Group, Redondo Beach, CA (USA). Applied Technology Div. Jun 1989. 143p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC22-87PC90274. Order Number DE90001081/JAW. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

This sixth quarterly technical progress report of the MHD Integrated topping Cycle Project presents the accomplishments during the period November 1, 1988 to January 31, 1989. The scope of work covered by this quarterly report encompasses systems engineering and data analysis, prototypical combustor and channel design studies, design support engineering for the prototypical hardware, and 50 MWt power train test preparations. 60 figs., 29 tabs.

47259 (INIS-mf–11537, pp. 26) **Plasma driven MHD power plant.** Messerle, H.K. (Sydney Univ. (Australia). School of Electrical Engineering). Australian Inst. of Nuclear Science and Engineering, Lucas Heights (Australia). 1989. (CONF-8902130–: 17. AINSE plasma physics conference, Lucas Heights (Australia), 6-8 Feb 1989). In *17th AINSE plasma physics conference: conference handbook.* Order Number DE90600936/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

Abstract only.

3005 Fuel Cells

Refer also to citation(s) 47076, 47284

47260 (AD-A–207576/0/XAB) **Long-endurance underwater power system. Quarterly report, January-March 1989.** Aquanautics Corp., Alameda, CA (USA). Mar 1989. 89p. Available from NTIS, PC A05/MF A01.

Major activities undertaken in this quarter were: (1) Direct Feed of Oxygen Carrier into Fuel Cell: Previous work carried out with carrier in a half-cell has been extended to a fuel cell where H_2 has been incorporated as the fuel. The positive power obtained 0.17 10 mA/sq. cm in the fuel cell is in itself a major achievement. Performance analysis points to the possibility of improvement in the hydrogen anode and the carrier, as well as a reduction in IR losses; (2) Gill: For operation at depth, gill membrane elements need to be of a solid type rather than microporus. Another requirement being that hollow fiber membranes are necessary, implies a very limited number of sources of supply. Aquanautics has been able to identify a source and has already tested a cartridge from them. The microporous control cartridge and solid membrane had roughly similar oxygen flux characteristics, and the difference was attributable to the geometry of the cartridges. Oxygen transport through the membranes has been modelled and the results are expected to yield design equations enabling selection of gill geometry and design parameters; (3) Hydrogen Generator: Subsequent to the feasibility study of hydrogen generation by reacting seawater with aluminum, Alupower, Inc. has delivered a 1W-1 month Al-Seawater battery/hydrogen generator. The system is compact and will be tested. Based on the work done in this quarter, the system volume targets for a one kilowatt system operating continuously for a period of one year have been formulated.

47261 (CONF-890815–26) **Fuel cells for vehicle propulsion applications: A thermodynamic systems analysis.** Kumar, R.; Krumpelt, M.; Misra, B. Argonne National Lab., IL (USA). [1989]. 7p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract W-31109-ENG-38. From 24. intersociety energy conversion engineering conference; Arlington, VA (USA); 6-11 Aug 1989. Order Number DE89017689/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The liquid- and air-cooled phosphoric acid, the proton exchange membrane, and the monolithic solid oxide fuel cell systems were analyzed for use in vehicle propulsion applications. System efficiency and input energy distribution were examined as a function of electrochemical fuel-utilization and other operating parameters. The liquid-cooled phosphoric acid and the monolithic solid oxide fuel cell systems have efficiencies approaching 40%; the air-cooled phosphoric acid and the proton exchange membrane fuel cells offer efficiencies near 30%. Thus the efficiencies of all of these fuel cell systems are much greater than the efficiencies of internal combustion engines. Our analyses indicate further that these fuel cells should be operated at the highest practical electrochemical fuel utilization rates for best efficiency and dynamic response, as well as minimum component volume and cost.

47262 (CONF-8409210–, pp. 453-488) **Theoretical studies of chemical reactions: Pyrolysis of formaldehyde.** Dunning, T.H. Jr. (Argonne National Lab., IL (USA)); Harding, L.B.; Wagner, A.F.; Bair, R.A.; Shepard, R.L.; Davis, M.J.; Bowman, J.M.; Schatz, G.C. Oak Ridge National Lab., TN (USA); Texas A and M Univ., College Station, TX (USA). Dept. of Chemistry. 1984. DOE Contract W-31-109-ENG-38. From Texas A and M symposium on theory, modeling and instrumentation for materials design; College Station, TX (USA); 17-19 Sep 1984. In *Theory, modeling and instrumentation for materials by design. Proceedings of workshop.* Order Number DE89007940/JAW. Available from NTIS, PC A99/MF A01.

First the authors briefly describe the theoretical chemistry program at Argonne National Laboratory (ANL) and its role in the combustion chemistry program sponsored by the US Department of Energy. Second, they briefly describe one of the projects that they have been involved in over the past year, namely, the pyrolysis of formaldehyde. The oxidation of simple hydrocarbon fuels, theoretical studies of the energetics, rates and mechanisms of reactions can contribute significantly to our understanding of the chemistry involved. Modern theoretical techniques, similar to the ab initio techniques discussed by others here, can be used to calculate the rates of chemical reactions which, with some empirical adjustments, agree well with the rates obtained from experiment. The calculated data allow the rates to be extrapolated to temperature and pressure regimes in which experiments are unavailable. This is most important for chemical reactions are most easily studied at temperatures far below flame temperatures. Recent advances in both theoretical methodology and computational technology suggest that such studies will become even more important in the future.

47263 (N–89-20545) **Mars manned transportation vehicle.** Perez-Davis, M.E.; Faymon, K.A. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Jul 1987. 12p. (NASA-TM–101487;E–4627;NAS–1.15:101487;CONF-8707205–: Case for Mars 3 conference, Boulder, CO (USA), 18-22 Jul 1987). Available from NTIS, PC A03/MF A01.

A viable power system technology for a surface transportation vehicle to explore the planet Mars is presented. A number of power traction systems were investigated, and it was found that a regenerative hydrogen-oxygen fuel cell appears to be attractive for a manned Mars rover application. Mission requirements were obtained from the Manned Mars Mission Working Group. Power systems weights, power, and reactants requirements were determined as a function of vehicle weights for vehicles weighing from 6,000 to 16,000 lb (2,722 to 7,257 kg), (Earth weight). The vehicle performance requirements were: velocity, 10 km/hr; range, 100 km; slope climbing capability, 30 deg uphill for 50 km; mission duration, 5 days; and crew, 5. Power requirements for the operation of scientific equipment and support system capabilities were also specified and included in this study. The concept developed here would also be applicable to a Lunar based vehicle for Lunar exploration. The reduced gravity on the Lunar surface, (over that on the Martian surface), would result in an increased range or capability over that of the Mars vehicle since many of the power and energy requirements for the vehicle are gravity dependent.

32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

Refer also to citation(s) 46882, 47243, 47323

3201 Buildings

Refer also to citation(s) 46907, 46909, 46910, 46917, 47047, 47075, 47237, 47242

47264 (DOE/CE–0267) **Technical support document: Energy conservation standards for consumer products: Dishwashers, clothes washers, and clothes dryers including Environmental Assessment (DOE/EA-0386) Regulatory Impact Analysis.** USDOE Assistant Secretary for Conservation and Renewable Energy, Washington, DC (USA). Building Equipment Div. Jul 1989. 433p. Sponsored by U.S. DOE Conservation & Renewable Energy. Order Number DE89016794/JAW. Available from NTIS, PC A19/MF A01 - OSTI; GPO Dep.

The Energy Policy and Conservation Act (PL 94-163), as amended by the National Appliance Energy Conservation Act of 1987 (PL 100-12) and by the National Appliance Energy Conservation Amendments of 1988 (PL 100-357), provides energy conservation standards for 14 types of consumer products and authorizes the Secretary of Energy to prescribe amended or new energy standards for each type (or class) of covered product. The

assessment of the proposed standards for the three types of products presented in this document is designed to evaluate their economic impacts according to the criteria in the Act. It includes an engineering analysis of the cost and performance of design options to improve the efficiency of the products; forecasts of the number and average efficiency of products sold, the amount of energy the products will consume, and their prices and operating costs with and without the standards; a determination of change in investment, revenues and expenditures by manufacturers of the products; a calculation of the costs and benefits to consumers, electric utilities and the nation as a whole; and an assessment of the environmental impacts of the proposed standards. 50 figs., 141 tabs.

47265 (DOE/CE/30806–T3) **Residential passive solar research activities related to IEA Task 8: Final report.** Architectural Energy Corp., Boulder, CO (USA). 1 Jun 1989. 173p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC03-84CE30806. Order Number DE89016009/JAW. Available from NTIS, PC A08/MF A01 - OSTI.

As part of the involvement of the United States in the International Energy Agency (IEA) Task 8 on Passive and Hybrid Solar Low Energy Buildings, two residential buildings were built to investigate the application of passive solar techniques in US climates. Architectural Energy Corporation (AEC), the contractor to the US Department of Energy for these activities, organized and guided the participation of two teams to design and build the homes. AEC provided the design-build teams with engineering and economic analysis during the design process and monitoring the thermal performance of the completed buildings. Included in this report are a description of the buildings, significant steps in the design process, an overview of the monitoring process, and results from the thermal monitoring. Also included are the responses provided by the owner and occupant of the west unit to questions on the "Class C" questionnaire. This is the same questionnaire that was used in the Department of Energy's Class C passive building performance evaluation program in the early 1980s. 8 refs.

47266 (ETSU-S–1214) **Methodology of window thermal performance assessment techniques in the US and the UK.** Robinson, P.; Littler, J. UKAEA Harwell Lab. (UK). Energy Technology Div. 1989. 101p. Available from British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ.

This report details methods of window thermal performance assessment currently being used in the US and UK. General descriptions are given of the experimental techniques and their relative merits. The report describes in detail the techniques which were used to test an advanced, four pane glazing system and standard double glazed unit. The results from each test are critically intercompared.. The glazing simulation models, WINDOW 2.0 (Lawrence Berkeley Laboratories, US.), MULTB (Pilkington Glass, UK), and VISION (Univeristy of Waterloo, Canada) are used to address the problem of glazing performance prediction. Simulation of the two glazing systems which were experimentally assessed allows intercomparison between models, and between predicted and measured performance. All three models show good agreement with measured data. The sophistication of glazing treatment in the building energy simulation models SERI-RES, ESP, and HTB2 are examined, and ESP is found to include the most comprehensive and thorough treatment. As a result of glazing and building simulation model consideration, the conclusion is drawn that SERI-RES may benefit from the additional capabilities of WINDOW 2.0, using its output of glazing properties as input to SERI-RES. (author).

47267 (FAGO/ESRU–89.08.K) **Outcome of 1988 work-stay at the University of Strathclyde in Glasgow, Scotland.** Hensen, J.L.M. Technische Hogeschool Eindhoven (Netherlands). Vakgroep Fysische Aspekten van de Gebouwde Omgeving; Strathclyde Univ., Glasgow (UK). Energy Simulation Research Unit. Apr 1989. 55p. (NOVEM–89-056). Available from Technische Universiteit Eindhoven, Vakgroep FAGO, P.O. Box 513, 5600 MB Eindhoven, Netherlands.

Work done within the framework of a collaborative research project concerning building design and auxiliary heating system of a house in relation to thermal comfort and energy consumption is described. For this and related research projects, it is necessary to model the combined building and plant system simultaneously. To this purpose the computer program package ESP (Environmental Systems Performance) will be extended. Simulation of a mass flow network has many similarities with building air flow modelling, of which ESP is already capable. It was investigated whether it is feasible to alter the ESPair module in such a way that it can also be used for plant system fluid flow modelling. In this respect the mathematical characterisations for the possible flow/pressure difference relationships were derived. The implementation of a new air flow equation solver in ESP is described. The current status of ESP with respect to system simulation is indicated. For this, short descriptions are given of the building and plant matrix handling, the currently available plant component models and the currently available plant control features. As a brief indicative demonstration of the present plant simulation possibilities some example calculations were carried out and the results are described. Some very interesting new developments with respect to building energy modelling in particular and CABD (Computer Aided Building Design) in general, originate and are being steered from within the University of Strathclyde. A general indication of the future developments with respect to CABD is given. Two research projects are briefly described: the energy kernel system and the intelligent front-end for building performance evaluation systems. Finally a work scheme is given for the remainder of the research project on the interaction between house and heating system. 43 refs., 3 apps.

47268 (IBP-GB–14/86) **Thermal behaviour of transparent layers of insulation on building facades - comparison of measurement and calculation. Interim report.** Schreiber, E.; Heim, U.; Boy, E. Fraunhofer-Institut fuer Bauphysik, Stuttgart (Germany, F.R.). Bereich Waerme/Klima; Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 15 Dec 1986. 20p. (In German). Contract BMFT 03E-8411-A. Order Number DE90702823/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

The comparison of experimentally determined results with numerical calculations for transparent insulated wall elements showed very good agreement in thermal behaviour, in the maximum values of surface temperatures and in long-term mean values. The precondition for the calculation is that the radiation physics behaviour of the transparent insulation shell should be known, and that thermal bridges in the wall structure, e.g. mounting frames, fans etc. should be included in the thermal behaviour with equivalent material values. Uncertainties in the room air temperatures can lead to large relative deviations in the comparison between measured and calculated heat flows. (orig.) With 3 tabs., 3 figs.

47269 (IBP-SA–3/85) **Heat energy saving by walls with transparent thermal insulation layers - measured results in idealised boundary conditions. Interim report.** Lang, H.; Boy, E.; Bertsch, K. Fraunhofer-Institut fuer Bauphysik, Stuttgart (Germany, F.R.). Bereich Waerme/Klima; Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). 6 Sep 1985. 29p. (In German). Contract BMFT 03E-8411-A. Order Number DE90702824/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

Measurements on differently orientated transparent insulated wall elements with different wall materials and different systems of insulation have produced favourable results for the new type of insulation. From the results obtained at Stuttgart during the heating period 1984/85, in comparison with the conventional opaque thermal insulation, not only was a further energy saving found, but when used on south walls during the winter months, an excess of heat could even be achieved. The systems of insulation used in the investigations, which were not yet optimized, showed energy gains of between about 50 and 90 kWh/m^2 compared with opaque thermal insulation. The wall material only played a part in the application of transparent insulating materials from the energy point view if the excess heat could be used. (There is a separate report on the thermal effects of different wall materials.) Depending on the climatic boundary conditions, the insulating effect or the degree of radiation transmission have greater importance for the material values of the insulating material. As the measurements were carried out in idealized internal conditions, the results cannot be directly transferred to other applications. (orig.) With 8 tabs., 4 figs.

47270 (ORNL/CON–274) **Model for roof thermal performance.** Wilkes, K.E. Oak Ridge National Lab., TN (USA). Jul 1989. 78p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE89015687/JAW. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This report describes a model that has been developed for predicting heat flows and temperatures within roof systems. The model is called STAR (for Simplified Transient Analysis of Roofs). It applies to transient one-dimensional conduction in multilayer roof systems and is fully coupled to ambient weather conditions. It has been implemented on a personal computer and has been designed to be easy to use for a variety of problems. The report gives details of the mathematical model and a verification of the model by comparing its predictions with existing experimental data. 9 refs., 30 figs., 4 tabs.

47271 (ORNL/FTR–3307) **[Briefings on low slope roof system meetings]: Foreign trip report, June 4, 1989–June 15, 1989.** Courville, G.E. Oak Ridge National Lab., TN (USA). 28 Jun 1989. 13p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE89017469/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

G. E. Courville chaired a meeting of the IEA Annex 19 on Low Slope Roofs held at the Chalmers University in Goteborg, Sweden on June 6-7, 1989. Representatives from the United States, United Kingdom, Sweden Denmark, and Switzerland were in attendance. The Annex reviewed material prepared by different countries for the scheduled Annex document on "Good Practices for Design, Installation, and Maintenance of Insulated Roofs." The format for additional background data was agreed upon. On June 14, Courville presented a briefing for the IEA/BCS Executive Committee on Annex Activities. Courville visited the Norwegian Building Research Institute (NBI). NBI built the world's first environmental chamber for roofs in the early 1970s and continue to be innovative in buildings research and development. They produce and sell an excellent grade of heat flux transducers and various laboratory testing equipment. E. Paulsen of NBI has developed a roof uplift test procedure that is potentially useful in the US. Courville visited with Roger Bonafont of Ruberoid Limited and Nick Cook of BRE. Both these groups have experience and laboratory data on uplift testing which will be conveyed to the Steering Committee for a workshop on Uplift Testing in the United States.

47272 (ORNL/M–879) **Building Thermal Envelope Systems and Materials (BTESM) and research utilization/technology transfer progress report for DOE Office of Buildings and Community Systems: Monthly progress report.** Coleman, G.; Samples, S.D. (comps.). Oak Ridge National Lab., TN (USA). Jun 1989. 39p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE89015666/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The monthly report of the Building Thermal Envelope Systems and Materials (BTESM) Program is a monthly update of both in-house ORNL projects and subcontract activities in the research areas of building materials, wall systems, foundations, roofs, building diagnostics, and research utilization and technology transfer. Presentations are not stand-alone paragraphs every month. Their principal values are the short-time lapse between accomplishment and reporting and their evolution over a period of several months.

47273 (PB–89-189153/XAB) **Evaluating office lighting environments: Second-level analysis.** Collins, B.L.; Fisher, W.S.; Gillette, G.L.; Marans, R.W. National Inst. of Standards and Technology, Gaithersburg, MD (USA). Apr 1989. 143p. (NISTIR–89/4069). Available from NTIS, PC A07/MF A01.

See also PB–88-164512.

Data from a post-occupancy evaluation (POE) of 912 work stations with lighting power density (LPD), photometric, and occupant-response measures were examined in a detailed, second-level analysis. Seven types of lighting systems were identified with different combinations of direct and indirect ambient lighting, and task lighting and daylight. The mean illuminances at the primary task location were within the IES target values for office task with a range of mean illuminances from 32 to 75 fc, depending on the lighting system. The median LPD was about 2.36 watts/sq ft, with about one-third the work stations having LPD's at or below 2.0 watts/sq ft. Although a majority of the occupants (69%) were satisfied about their lighting, the highest percentage of those expressing dissatisfaction (37%) with lighting had an indirect fluorescent furniture-mounted (IFFM) system. The negative reaction of so many people to the IFFM system suggests that the combination of task lighting with an indirect ambient system had an important influence on lighting satisfaction, even though task illuminances tended to be higher with the IFFM system. Concepts of lighting quality, visual health, and control were explored, as well as average luminance to explain the negative reactions to the combination of indirect lighting with furniture-mounted lighting.

47274 (PEUTZ-E–160-2) **Study on large glass covered spaces. Section report of the research project 'Climate and energy'.** Nederlandse Maatschappij voor Energie en Milieu BV (NOVEM), Sittard (Netherlands). Apr 1989. 114p. (In (In Dutch)). (NOVEM–89-052). Available from Adviesbureau Peutz en Associes BV, P.O. Box 407, 6500 AK Nijmegen, Netherlands.

Within the framework of a general study on different designs for large glass covered spaces (LGCS) a subproject with regard to the aspects climate and energy has been carried out. The impact of several design parameters on the energy consumption and the thermal indoor climate of buildings with LGCS was determined. Heating, ventilation and/or cooling of offices and LGCS, the desired climate within the LGCS, the application of sun-blinds, dimensions of the LGCS, etc., are taken into account. The study is based on computer simulations. A description of the calculation model is given. A selection of product models of LGCS is given from which the architect or designer can choose the most representative option according to his own design. Finally some outlines are elucidated from these models. For every parameter basic design guidelines can be formulated to dimension future energetic sound LGCS concepts. 10 figs., 1 app.

47275 (TKK-KO/LVI–B24) **Performance of ventilation systems in residential buildings.** Roennberg, R.; Ruotsalainen, R.; Majanen, A. Helsinki Univ. of Technology, Otaniemi (Finland). Lab. of Heating, Ventilation and Air Conditioning. 1989. 109p. (In Finnish). Order Number DE89914701/JAW. Available from NTIS (US Sales Only), PC A06/MF A01.

The aim of the study was to gather information on the performance of ventilation systems in residential buildings. The effect of the ventilation on health, comfort and satisfaction was also studied. Data was also collected of the fullfilment of National Building Code on ventilation. 50 residential buildings were selected for the study, which was carried out during the heating season 1987-88. The sample consisted of both detached houses and blocks of flats. Same amount of most common ventilation systems was taken into the sample. Ventilation rates and indoor climate were measured and a questionnaire on symptoms, health and comfort was carried out during the measurements. The ventilation rates varied from 0.1 to 1.2 m^3/hm^3 (with an average of approzimately 0.5 m^3/hm^3) in typical operation conditions, i.e. as the ventilation was operated most of the day. The ventilation rate in the bedrooms was usually smallest. The ventilation rate was typically highest in the bedrooms with balanced ventilation. The ventilation rate had an effect on health and symptoms. When the average ventilation rate in a dwelling was below 0.25 m^3/hm^3, occupants expressed several symptoms; and when the ventilation rate was above 0.55 m^3/hm^3, occupants expressed few or no symptoms. A correlation between the sensation of indoor air quality and measured indoor parameters was also found. No statistically signiicant correlation was found in symptoms or satisfaction between the ventilation system.

47276 (VTT-TIED–960) **Energy consumption of single-family houses. Partly storing electrical heating.** Siltanen, T.; Rantatalo, E. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Mar 1989. 82p. (In Finnish). Order Number DE89914691/JAW. Available from NTIS (US Sales Only), PC A05/MF A01.

Annual efficiency and energy consumption of an electrical, partly storing water radiator heating was studied in new single-family houses. Energy for space heating was delivered using water radiators, floor and air heating. Significant part of the energy brought to the storage tank was lost because of poor isolation. The efficiency varied monthly from 45% to 85% with an average of 78%. The average isolation losses of the reservoirs ranged from 440 W to 590

W, exceeding the corresponding losses measured in laboratory conditions. However, it is possible to utilize part of the insulation losses in space heating by optimizing the storage tank location. The energy consumption of the houses was similar to the results of earlier studies. The average energy that was delivered to houses was 29 743 kWh/a (excluding the energy from wood combustion) and 33 174 kWh/a (including the energy from wood combustion). The characteristic energy consumption of the houses varied from 47.2 to 52.7 kWh/m^3/a. The average energy taken from water storage tank was 21 442 kWh/a, of which about 1 943 kWh was produced with the wood boiler. Household electricity energy consumption was about 6 813 kWh/a. The houses with air heating systems had highest electricity energy consumption. Heating domestic hot water consumed energy on an average 2 989 kWh/a. Average annual water consumption was 180 m^3. The characteristic water consumption varied in different households from 58 to 181 dm^3/person/d with an average of 118 dm^3/person/d. Houses with a small storage tank had the smallest water consumption.

47277 (VTT-TIED–971) **Outdoor air intake in dwellings equipped with mechanical exhaust ventilation.** Luoma, M.; Siitonen, V. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Apr 1989. 83p. (In Finnish). Order Number DE89914693/JAW. Available from NTIS (US Sales Only), PC A05/MF A01.

Outdoor air intake in dwellings equipped with mechanical exhaust ventilation is studied. The goal is to control both air flows and thermal conditions in the occupied zone. The stability of the outdoor air flow of a bed room in a detached house and in a block of flats was studied by calculations. Only when the pressure difference between the outdoor and indoor air exceeds 20 Pa in the design situation, are the variations in the outdoor air flow small, if the air is taken in directly from the outside. Hence in a sheltered terrain a pressure difference of 10 Pascals is enough. A field test was made to study whether a supply air window could be arranged in an existing apartment building. The supply air window was arranged so that a calculated length of weather strip was removed. It was found that this kind of design of the flow ways involves many uncertainties, this explaining why the desired distribution of outdoor air flows in the flats investigated was not fully achieved. Nevertheless, the outdoor air intake remained draughtless. Controlling the thermal conditions was studied in laboratory conditions by testing the draughtiessness of some outdoor air inlets marketed in Finland. The largest draughtless air flow obtained with the best outdoor air inlet was less than 6 dm^3/s, when the outdoor temperature was -20 deg C and the pressure difference was a maximum of 10 Pa. This air flow is only enough to satisfy the need air flow of 1.5 persons. Later checking of the measuring method seemed to give even smaller air flows. As a measure to control the outdoor air flows in a room, the right design of flow ways, a ventilating air space and constant flow air inlets are suggested. The thermal conditions can be controlled by the right choice for the outdoor air inlet.

3202 Transportation

47278 (PB–89-170369/XAB) **HRIS (Highway Research Information Service) Abstracts. Volume 21, Number 1 - Spring 1988.** National Research Council, Washington, DC (USA). Transportation Research Board. 1988. 448p. Available from NTIS, PC A19/MF A01.

See also PB–89-170377. Library of Congress catalog card no. 75-642521.

This publication provides information about highway and nonrail mass-transit research. It is compiled from computer records of the Highway Research Information Services (HRIS), an important subfile of the Transportation Research Information Services (TRIS) data base. Each issue consists of four sections: Abstracts of research reports, technical papers in conference proceedings, and journal articles, grouped by subject area; Source Index listing names and addresses of corporate authors; Author Index listing names of personal authors and coauthors of reports, papers, and articles; and Retrieval-Term Index listing subject terms from the HRIS Subject Terms List (with frequency counts), from the HRIS Thesaurus Term List and other terms useful in retrieving abstracts published in the issue.

47279 (UCRL–21156) **Transatospheric laser propulsion: Final report.** Myrabo, L.N. Lawrence Livermore National Lab., CA (USA); Rensselaer Polytechnic Inst., Troy, NY (USA). Dept. of Mechanical Engineering. 15 Aug 1988. 118p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CONF-880764–7: 24. AIAA/ASME/SAE/ASEE joint propulsion conference, Boston, MA (USA), 11-13 Jul 1988). Order Number DE89017528/JAW. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The detailed description and performance analysis of a 1.4 meter diameter Lightcraft Technology Demonstrator (LTD) is presented. The novel launch system employs a 100 MW-class ground-based laser to transmit power directly to an advanced combined-cycle engine that propels the 120 kg LTD to orbit – with a mass ratio of two. The single-stage-to-orbit (SSTO) LTD machine then becomes an autonomous sensor satellite that can deliver precise, high quality information typical of today's large orbital platforms. The dominant motivation behind this study is to provide an example of how laser propulsion and its low launch costs can induce a comparable order-of-magnitude reduction in sensor satellite packaging costs. The issue is simply one of production technology for future, survivable SSTO aerospace vehicles that intimately share both laser propulsion engine and satellite functional hardware. 12 refs., 31 figs.

47280 (VTT-TIED–939) **Methods for municipal traffic safety work - improvement of traffic environment. A literature survey.** Leden, L.; Peltola, H.; Roine, M. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). Feb 1989. 130p. (In Finnish). Order Number DE89914695/JAW. Available from NTIS (US Sales Only), PC A07/MF A01.

The purpose of this literature survey was to collect research results in order to renew the guidelines for municipal traffic safety activities, mainly traffic engineering techniques for urban environments and the problems of unprotected road users. A new method is recommended in the selection of locations that would require safety measures. The selection would be based on the classification of the safety level acording to a method described in General guidelines for plannin urban traffic networks, TRAAD, which has to be calibrated for Finnish conditions. Other data for the method is collected through surveys on school children and traffic counts concentrated in unprotected road users. The report gives an example of the use of school children's survey data. The expected values and variance of the accident risk should be studied in different conditions in order to make traffic safety work more efficient. In addition, the TRAAD method should be developed further in describing the safety of walking and cycling school children. The counting of motor vehicle, bicycle, and pedestrian flows should be encouraged in urban areas. Guidelines for performing counts of unprotected road users should be prepared as this enables the use and comparison of count data from different municipalities. Four different strategies exist for the selection of locations to be treated by applying safety masures: area action plans, mass action plans, route action plans, single sites. The need for safety measures should be studied for all areas on a long-term basis. All areas must meet the goals that have been set for the level of traffic safety. The report presents a summary of studies concerning the effects of different safety measures. In addition, the report contain information about design standards, measure selection criteria, measure proposals, the setting of the priority order of measures and the monitoring of safety activities.

3203 Industry and Agriculture

Refer also to citation(s) 47050, 47349, 47485, 47843, 48000, 48037

47281 (AFME–86.02.0063) **Heat exchangers: a strategic analysis.** Finkbeiner, F.; Durand, T.; Gonard, T.; Pierre, B.; Ribier, B.; Leray, T. Agence Francaise pour la Maitrise de l'Energie, 75 - Paris (France). Jun 1987. 86p. (In French). Order Number DE89764077/JAW. Available from NTIS (US Sales Only), PC A05/MF A01.

The results of a ten years activity of the french Energy Conservation Agency (AFME) in the fields of heat exchangers are presented and analyzed. The heat exchanger program was concerned with three objectives: enhancement of the heat exchanger utilization in industry for the lowering of energy consumption in France, increase

of the heat exchanger efficiency and improvement of the heat exchanger industry: technological research and development programs with the aim to enhance the exportation competitivity of this industry.

47282 (DOE/BP/64849–1) **Power factor controller study.** Knudson Engineering, Inc., Portland, OR (USA). Aug 1989. 91p. Sponsored by U.S. DOE Management & Administration. DOE Contract AM79-86BP64849. Order Number DE89017655/JAW. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The complete report is divided into three parts as follows: (1) This report combines a historical perspective with a current assessment of the use of power factor controllers for three-phase ac motor energy savings. The power factor controller (PFC) is a power electronics device that reduces voltage to a motor during periods of reduced motor torque requirements. (2) A power factor controller (PFC) is a power electronics device that reduces voltage to a motor during periods of reduced motor torque requirements. This report is the DEMONSTRATION phase of the PFC study. The phase report consists of three task reports – Site Selection, Demonstration Preparation, and Demonstration. The reports explain how three sites were selected for demonstration, describe what was measured at each site and the method of measurement, and compare measured energy savings with calculated predictions of energy savings. The report concludes that PFCs can save energy on carefully selected motor applications. (3) The results of the demonstration task are described in this report. A power factor controller (PFC) is a power electronics device that reduces voltage to a motor during periods of reduced motor torque requirements. The demonstration phase of this study calculates projected energy savings with the use of a PFC and compares measured performance with the calculations. The effect of the PFC on motor power requirements, power factor and energy consumption shall be measured.

47283 (DOE/CE/40740–T4) **A comprehensive program to develop correlations for the physical properties of kraft black liquors.** Fricke, A.L. Florida Univ., Gainesville, FL (USA). Jul 1989. 110p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG02-85CE40740. Order Number DE89016404/JAW. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The major accomplishments during the period extending from August 1, 1987 to July 1, 1989 were design and construction of a pilot plant building; design, fabrication, installation, testing, and initial operation of a 3.5 ft^3 digester system for kraft pulping and a large scale evaporator system for liquor concentration; specification, purchase, and installation of new instruments for lignin characterization; major revision of rheological instruments; specification, purchase, installation, and initial operation of instruments for determining heats of combustion and heats of dilution; extensive revision of techniques for thermal studies; and staff development. Laboratory and pilot scale facilities for conducting experimental kraft pulping, for concentrating experimental and mill liquors for research for complete analysis of liquors, and for rheological and thermal properties measurements for kraft black liquors are now completed. 44 figs.

47284 (DOE/MC/22012–2726) **Fuel cells application in the industrial sector: Task 15, Final report.** Hackworth, J.H.; Shore, J.V. KOH Systems, Inc., Rockville, MD (USA); On Location, Inc., Reston, VA (USA). Nov 1988. 93p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC21-85MC22012. Order Number DE89011689/JAW. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This study examined the potential application of fuel cells in the industrial cogeneration market. The study was carried out in two phases. The first phase screened the high energy use industries analyzing energy requirements, number and variety of plants in the industry and the current level of cogeneration activity in the industry. Based on the screening analysis, two industries, chemicals and steel were selected for detailed study, because they are large energy users, currently make use of cogeneration, provide diversity from each other geographically and in size of facilities and power-to- heat usage, and both rely on gas and coal for cogeneration. Moreover, there was an interest in studying the gas waste streams available in both these industries as candidate fuels for cogeneration using current technologies and the fuel cell. The detailed analysis followed a four step process: energy profiles for a range of chemical and steel plants were developed; the best alternative cogeneration technology was determined for the plants; the maximum installed capital cost for a molten carbonate fuel cell (MCFC) competitive with the best alternative cogeneration technology was calculated; and sensitivity analysis for key technology and market variables was carried out. 41 refs., 7 figs., 29 tabs.

47285 (EGG-M–88520) **Irreversibility reduction of low-temperature, combustion heat sources.** Bliem, C.J. EG and G Idaho, Inc., Idaho Falls, ID (USA). 1989. 6p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC07-76ID01570. (CONF-890815–22: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989). Order Number DE89016200/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper discusses a concept that will reduce irreversibilities associated with combustion and, thereby, deliver more heat to a process than the heating value of the fuel. The concept involves the use of staged reactions to facilitate the more reversible reactions associated with the combustion process. The system is an open cycle chemical reaction heat pump working between the atmosphere and the desired heat sink. The system is described in the paper. The paper discusses the potential efficiency of this system and the methodology of searching for the required intermediate components. 4 refs., 10 figs.

47286 (ETDE-mf–0702816) **Development and testing of a physical measurement system for exploring heated groundwater flows, e.g. for heat recovery with the aid of water/water heat pumps.** Sebulke, J. Technische Univ. Berlin (Germany, F.R.). Inst. fuer Angewandte Geophysik, Petrologie und Lagerstaettenforschung. 29 Apr 1986. 21p. (In German). Contract ERP 2508 - IV E 2. Order Number DE90702816/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

The aim of a research project explained in detail, was to find and to assess local hot groundwater flows (waste heat in groundwater of industrial areas), by developing suitable methods of measurement, in order to make it possible to introduce environmentally acceptable energy recovery plants. Partial results of work area A are submitted and commented on: measuring known heat sources for groundwater heating; work area B: geo-electrical model experiments, simulation of groundwater flows, testing of different arrangements for thermal and electrical measurements; part area C: verifying a multi-channel computer-controlled measurement system for thermal and electrical measurements; work area D: development of a mathematical formula for calculating the potential of earthed electrodes in half-areas in layers with ellipsoid interference bodies inserted. (HWJ).

47287 (FRNC-TH–3498) **Energy analysis of large-scale crop farms: impact of energy crisis and future prospects.** Oury, F.X. Institut National de Recherches Agronomiques (INRA), 75 - Paris (France). 1986. 268p. (In French). Order Number DE90702240/JAW. Available from NTIS (US Sales Only), PC A13/MF A01.

This work, is composed of two parts: -A study, from 1971 to 1982, of the impacts of the energy crisis on a sample of large-scale crop farms from petite Beauce du Loiret. First, an empirical approach shows that the increase in input prices has led to a decrease in fuel and phospho-potassic fertilizer consumptions. On the contrary nitrogenous fertilizer and pesticide uses keep on growing for these two factors have a strong effect on yields and farmers adjust usage to the ever increasing crops potentialities. Secondly, a more theoretical approach based on translog estimate of a production function, allows study of substituabilities and complementarities between the production factors capital, energy, labour, and inputs except fuel. It appears that petrol crises have not disrupted the relationships between the factors: particularly they have not caused the substitution of labour for energy. It appears also that large-scale crop farms are currently in a rationalization phase characterized by a capital reduction, which constitutes the principal explanation for the decrease in fuel consumption. This first part brings the energy problem back to its real dimension for these large cereal and beets farms: energy crisis has not transformed intensive systems into extensive ones. - A study, using monoperiodic and dynamic linear programming models, of the practicabilities for large-scale crop farms to produce or save energy, these systems being the most able to receive innovation. While studying opportunity costs and

threshold prices, a first series of optimizations shows that energy crop development cannot appear in the middle-term, because of a strong valorization of agricultural products by food industry. A second series of optimizations points out, on the contrary, that there is no obstacle for a thermochemistric valorization of wood or straw for internal uses in the farm-household system.

47288 (IMAG-Nota–400) **Energy study of the agricultural industry.** Instituut voor Mechanisatie, Arbeid en Gebouwen (IMAG), Wageningen (Netherlands); Nederlandse Maatschappij voor Energie en Milieu BV (NOVEM), Sittard (Netherlands). Nov 1988. 186p. (In (In Dutch)). (NOVEM–89-007). Available from Institute of Agicultural Engineering (IMAG), P.O. Box 43, 6700 AA Wageningen, Netherlands.

Marketing research for the Dutch agricultural industry was carried out in the field of environment and energy. The purpose was to develop suggestions with regard to a long range program for the agricultural sector. The study comprises the analysis of the energy consumption, future development and interviews with opinion leaders. Also 12 reports from the period 1983 to 1987 on energy conservation were evaluated. Finally some recommendations for a long-range program are given. Sections of the agricultural industry discussed, are the glasshouse culture, cattle forming, farming, horticulture, fishery, fruit growing culture and mushroom farming. 22 refs, 9 tabs., 2 apps.

47289 (ORNL/FTR–2969) **[Discussion of plastic media blasting]: Foreign trip report, 1988.** Gat, U. Oak Ridge National Lab., TN (USA). 21 Jul 1988. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017463/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The visit to MBB was to see and discuss the plastic media blasting equipment developed and manufactured as a cooperative effort by Schlick and MBB. The Germans emphasized a systematic approach and complete control over most parameters. The goal is to achieve conditions which do not cause damage to the aircraft. To arrive at the goal the air pressure that delivers the air to entrain the media, the flow rate of media, and the media itself are carefully and accurately controlled. Distance of nozzle and angle of blasting were systematically investigated. The wet (freon) cleanup system under development at Schlick was not discussed.

47290 (PB–89-142418/XAB) **Best demonstrated available technology (BDAT) background document for K103 and K104. Final report.** Baez-Martinez, J. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Aug 1988. 334p. (EPA–530/SW-88/031G). Available from NTIS, PC A15/MF A01.

See also PB–89-142350. Portions of this document are not fully legible.

This document provides the agency's rationale and technical support for selecting the constituents to be regulated in the K103 and K104 wastes and for developing treatment standards for those regulated constituents. The document also provides waste characterization and treatment information that serves as a basis for determining whether variances may be warranted.

47291 (PB–89-142442/XAB) **Best demonstrated available technology (BDAT) background document for K046 nonreactive subcategory. Final report.** Baez-Martinez, J. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Aug 1988. 141p. (EPA–530/SW-88/031J). Available from NTIS, PC A07/MF A01.

See also PB–89-142418.

In promulgating treatment standards for K046 nonwaste waters, the Agency has established subcategories: nonreactive and reactive. Treatment standards for the reactive subcategory of K046 nonwaste waters will be established at a later data. This background document provides the Agency's rationale and technical support for selecting the constituents to be regulated in the K046 waste and for developing treatment standards for those regulated constituents. The document also provides waste-characterization information that serves as the basis for determining whether variances may be warranted for a particular waste that has the same waste code but has waste characteristics that make it more difficult.

47292 (PB–89-142459/XAB) **Best demonstrated available technology (BDAT) background document for K101 and K102: Low arsenic subcategory. Final report.** Baez-Martinez, J. Environmental Protection Agency, Washington, DC (USA). Office of Solid Waste. Aug 1988. 387p. (EPA–530/SW-88/031K). Available from NTIS, PC A17/MF A01.

See also PB–89-142442. Portions of this document are not fully legible.

In promulgating treatment standards for K101 and K102 nonwaste waters, the Agency established two subcategories: Low Arsenic and High Arsenic. The Low Arsenic Subcategory is defined as those K101 and K102 wastes that contain less than 1% total arsenic. The High Arsenic Subcategory is defined as those K101 and K102 wastes that contain greater than or equal to 1% total arsenic. This document provides the Agency's rationale and technical support for selecting the constituents to be regulated in the K101 and K102 wastes and for developing treatment standards for those regulated constituents.

47293 (PB–89-208169/XAB) **RCRA (Resource Conservation and Recovery Act) inspection manual. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Waste Programs Enforcement. 22 Apr 1988. 376p. (EPA/OWPE–88/001). Available from NTIS, PC A17/MF A01.

The RCRA Inspection Manual is intended to assist RCRA field inspectors in their performance of Compliance Evaluation Inspections of RCRA generators, transporters, and treatment, storage, and disposal facilities. Included in the document are inspection procedures for both interim status and permitted facilities. The guidance also provides inspection checklists to aid the inspectors in their review of facility compliance. The Manual will assist RCRA inspectors and enforcement personnel to: conduct RCRA inspections efficiently and professionally, to determine facility compliance with RCRA regulations, adequately prepare for and conduct inspections at RCRA generators, transporters and TSD's, review facility permits for inspection of permitted facilities, and prepare quality inspection reports.

47294 (PNL-SA–17246) **Catalysis by design: A coordinated approach to catalyst research and development.** Fassbender, L.L.; Sen, R.; Eberhardt, J.; Keay, L. Pacific Northwest Lab., Richland, WA (USA). Aug 1989. 14p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC06-76RL01830. (CONF-890814–5: American Institute of Chemical Engineer's summer national meeting, Philadelphia, PA (USA), 20-23 Aug 1989). Order Number DE89016829/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Materials-by-Design approach is currently being extended to the research and development of industrial catalysts. The resulting program, referred to as "Catalysis-by-Design" (CBD), is the subject of this paper. The paper includes an overview of the CBD Program, an assessment of its potential impacts on the US catalysts industry, and a discussion of how government and industry can undertake a collaborative R and D effort in the field of catalysis. This last issue is particularly important, since most of the research information in industry is considered to be proprietary. 12 refs., 4 figs.

47295 Smelting networks for real time cooperative planning in the presence of uncertainties. Iyengar, S.S. (Dept. of Computer Science, Louisiana State Univ., Baton Rouge, LA (US)); Gulati, S.; Barhen, J. vp of Applications of artificial intelligence VI. Trivedi, M.M. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (1988). (CONF-880464–: Applications of artificial intelligence VI, Orlando, FL (USA), 4-6 Apr 1988).

This paper discusses the applicability and limitations of the conventional knowledge representations and AI paradigms in designing algorithms for multi-sensor fusion for the uncertainty prone multiple target tracking (MTT) problem. A knowledge-based framework for solution to this problem necessitates developing mechanisms for efficient online knowledge acquisition and exploration of alternate knowledge representations as the existing structures prove inadequate in this context. In this paper the authors describe the use of Smelting Networks for knowledge acquisition, target state representation, resolution of sensor ambiguities and environmental uncertainties. These networks are drawn from a biological cooperative phenomenon and used to encapture situational constraints,

determine track-to-target associations and avoid generation of redundant associations for trajectory estimation.

3206 Municipalities and Community Systems

Refer also to citation(s) 47027, 47208, 47255, 47293, 47946, 47950, 47955, 48021, 48061

47296 (DOE/CE/26576–T2) **District cooling systems central plant technologies: Progress report.** Fleming Group, East Syracuse, NY (USA). 20 Jul 1989. 21p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-88CE26576. Order Number DE89017265/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The specific scope of this report is to document the findings and experiences of URI's development of satellite energy centers in the City of New Haven. Innovative technologies and development approaches for district cooling have been an integral part of the URI's efforts. These have included analyses of alternate cooling technologies and thermal distribution systems, system development approaches, strategic development planning, energy and environmental considerations, customer and provider economics, and marketplace competition. Being the first in a series of reports, this document focuses on the exploration of cooling technologies which are compatible with the satellite energy center approach. The subjects include: a discussion of the satellite energy center development approach; descriptions of compatible and innovative cooling technologies; and evaluation of energy, environmental and economic issues related to the technologies. It is the intent of this report to provide technological information and marketplace experience which can provide guidelines to URI and others in future development of district cooling systems. 3 tabs.

47297 (ORNL/FTR–2833) **[Land disposal of solid waste]: Foreign trip report, March 13–21, 1988.** Francis, C.W. Oak Ridge National Lab., TN (USA). 31 Mar 1988. 26p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017408/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler participated in the Swiss Workshop on Land Disposal of Solid Waste. This workshop was financially supported by a variety of Swiss enterprises and public authorities whose objective was to assemble a select group of engineers, natural scientists, and economists from various European countries and the United States and Canada to discuss the criteria essential to qualify anthropogenic solid waste as being acceptable for final storage. The Workshop was structured to enhance informal discussions within four working groups of 10 to 12 participants, each group addressing specific questions relating to the landfill as a reactor and the landfill as a final storage facility. Conclusions of the workshop participants were (1) the landfill as a reactor could not be depended on to generate a waste of final storage quality and (2) if a landfill was to be used as a final storage facility, only wastes of final storage quality should be disposed of in such facilities. The most controversial items of debate were the criteria necessary to meet final storage quality. The major criteria for final storage quality agreed upon by the participants were (1) composition of the waste should be defined (within 95%), (2) total organic carbon of wastes should not exceed 5%, and (3) leachate concentrations emanating from the landfill should not be significantly different from natural concentrations in groundwaters and surface water adjacent to the landfill.

47298 (PB–89-138762/XAB) **Sludge Incineration Model (SIM) (for microcomputers). Model-Simulation.** Crumpler, G. Environmental Protection Agency, Washington, DC (USA). Office of Water Regulations and Standards. Apr 1989. vp. Available from NTISCP D99.

The software is contained on 5 1/4-inch diskettes, double density (360K), compatible with the IBM XT/AT microcomputer. The diskettes are in the ASCII format. Price includes documentation, PB–89-149314.

The model is a computer program for calculation of numeric criteria for incineration of sewage sludge under sewage-sludge regulations at 40 CFR Part 503. Software Description: The model is written in the Turbo Pascal programming language for use on an IBM XT/AT or compatible machines using DOS 2.2+ operating system. It requires a minimum of 640K of memory. Special requirements are the 8087 or 80287 Math Co-Processor and a Graphics Display Adapter.

47299 (PB–89-189443/XAB) **Study and assessment of eight yard waste-composting programs across the United States. Technical report.** Taylor, A.C. Harvard Univ., Cambridge, MA (USA). 30 Dec 1988. 58p. Available from NTIS, PC A04/MF A01.

This report looks at the methods and products of yard waste composting in the context of 8 programs currently in operation in the U.S., in order to provide information and options to communities faced with difficult choices in the area of Municipal Solid Waste (MSW) management. Yard wastes, i.e., debris such as grass clippings, leaves, brush, and tree prunings, have been estimated to comprise approximately 18% of the annual national MSW stream gross discards. Yard waste generation rates and composition vary by season, year, and region. In fact, during the peak months of their generation (i.e., primarily during the summer and fall months), yard wastes can represent 25-50% of the MSW stream. Yard-waste composting has great potential as a MSW management option, in the U.S. It is estimated that there are between 800 and 1,000 yard waste composting facilities in the nation and it is expected that many more will begin operation as the landfill situation becomes more critical. As the burden on landfills across the U.S. continues to increase and landfill tip fees continue to soar, many communities are beginning to look to yard waste composting to save landfill capacity and landfill disposal (and related) costs as well as to produce a useful end product.

47300 (PB–89-865661/XAB) **Sewage-treatment costs and economics. July 1987-July 1989 (Citations from the NTIS data base). Report for July 1988-July 1989.** National Technical Information Service, Springfield, VA (USA). Jul 1989. 46p. Available from NTISPC N01/MF N01.

Supersedes PB–87-864492. See also PB–89-865653.

This bibliography contains citations concerning the costs and economics involved in technology and systems for sewage treatment, sludge disposal, and sewer lines. Most of the studies cover the overall construction and operating costs of sewage-treatment plants. Other studies cover rate structures, financing, user charges, and benefits of regionalized plants. (This updated bibliography contains 64 citations, all of which are new entries to the previous edition.)

33 ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

Refer also to citation(s) 47261

3301 Internal Combustion Engines

Refer also to citation(s) 46826, 46884, 47028, 47619, 47621

47301 Experimental simulation of engine knock by means of a preheated static combustion chamber. Gabano, J.D. (Ecole Nationale Superieure de Mecanique et d'Aerotechnique, Poitiers (France)); Kageyama, T.; Fisson, F.; Leyer, J.C. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Vibratory combustions showing the same features as those of reciprocating engine knock are observed in an electrically preheated, two dimensional stainless steel spark ignited combustion chamber, using a mixture of n-butane and oxidizer (21% of oxygen and 79% of argon in volume) with equivalence ratio of 0.9. Combustions are performed for different initial temperatures, varying for 303 K up to 513 K, for a given initial density, so as to keep a constant energy content. The results of the experiments, undertaken for several initial densities between 6.2 kg/m^3 show that for an initial temperature lower than 423 K, only smooth pressure oscillations, whose amplitude is gradually amplified but never exceeds 1 bar, and due to acoustic-flame interaction, are observed. In contrast, with initial temperature over 423 K, pressure vibrations, initiated by strong pressure pulses which break into pronounced damped pressure

waves, characteristic of knocking combustion, are detected. The two types of vibratory phenomena are clearly distinguished by pressure-time-history signal analyses, and autoignition of the end-gas, which is the last part of the fresh mixture to be consumed by the normal flame propagation. The autoignition is evidenced by high speed schlieren cinematography during knocking combustions. Finally, means to characterize and quantify knock intensity related to the mixture used are studied.

47302 **Prediction of knock occurrence in a spark-ignition engine.** Chun, Kwang Min (Massachusetts Institute of Technology, Cambridge (USA)); Heywood, J.B.; Keck, J.C. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

It is generally accepted that knock in a spark-ignition engine is caused by end-gas autoignition. Hu and Keck have recently developed a reduced kinetic model which simulates the kinetic processes involved in autoignition of hydrocarbon-air mixtures. The model was used successfully to correlate measurements of explosion limits in a constant volume bomb and ignition delay times in rapid compression machines. In this paper, the ability of Hu and Keck's model to predict the onset of knock in a spark-ignition engine is evaluated. Experimental data from a large number of individual cycles were generated from a single-cylinder engine over a range of operating conditions where knock occurred. The unburned gas temperature used in the kinetic model was calculated from the measured cylinder pressure data assuming that knock originates in that part of the end-gas region which is compressed adiabatically. The model indicates that autoignition under knocking conditions is a two stage process. The model predictions of when knock occurs generally match well with measured knock angle on a cycle-by-cycle basis for a range of fuel (isooctane, primary reference, and indolene) and engine operating conditions. Agreement is least satisfactory when knock occurs close to the end of the burning process when the end-gas mass fraction is small and its temperature is not known precisely.

47303 **Mechanism of flame kernel formation produced by short duration sparks.** Kono, M. (Univ. of Tokyo (Japan)); Niu, K.; Tsukamoto, T.; Ujiie, Y. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

With reference to flame kernel developments in spark ignition of combustible mixtures, the formation process of hot kernels produced by short duration sparks (less than 0.3 μs) in an inert gas is modeled by using a set of partial differential equations with unsteady and two-dimensional cylindrical coordinates. These equations are solved numerically. The results show that the gas flow pattern governs the kernel configuration and that the kernel shape has some characterized features such as a torus, a torus with a groove and a nontoroidal shape. The simulated results are successfully verified by optical measurements.

47304 **Development of hot nitrogen kernel, produced by a very fast spark discharge.** Borghese, A. (Istituto Motori, Napoli (Italy)); D'Alessio, A.; Diana, M.; Venitozzi, C. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

In this work an experimental description has been given of some physical processes occurring and induced in atmospheric pressure nitrogen by very fast spark discharges. The time range investigated spans from the very first tens of nanoseconds (spark phase) up to the submillisecond scale. Experiments were based upon the application of both the laser-schlieren technique, yielding 2-D qualitative visualization, and the 1-D quantitative Rayleigh laser-light scattering, from which the gas mass density radial distributions were derived, for delays from the spark greater than 1 μs. Following the energy deposition stage, three main time domains have been identified, corresponding respectively to (i) the fast expansion of the excited gas kernel and of the resulting shock wave, (0.2-10 μs) (ii) the subsequent, ordered gas flow-field, involving recirculation of fresh gases into the spark gap (10-40 μs) and, finally, (iii) the transition of the coherent fluid dynamic structures toward chaotic, turbulent mixing of excited and cold gases (40-200 μs). Next, from the depolarized light scattering data in the range 5-15 μs, some indications were drawn, about the recombination process of the atomic nitrogen, which has been shown to have lifetimes of the order of tens of microseconds, thus exhibiting interesting properties as an efficient energy reservoir.

47305 (DOE/MC/22181–2694) **Coal-fueled diesel: Technology development: Final report.** Leonard, G.; Hsu, B.; Flynn, P. General Electric Co., Schenectady, NY (USA). Corporate Research and Development Center. Mar 1989. 172p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC21-85MC22181. Order Number DE89000984/JAW. Available from NTIS, PC A08/MF A01 - OSTI.

This project consisted of four tasks: (1) to determine if CWM could be ignited and burned rapidly enough for operation in a 1000-rpm diesel engine, (2) to demonstrate that a durable CWM-fueled engine could in principle be developed, (3) to assess current emissions control technology to determine the feasibility of cleaning the exhaust of a CWM-fueled diesel locomotive, and (4) to conduct an economic analysis to determine the attractiveness of powering US locomotives with CWM. 34 refs., 125 figs., 28 tabs.

47306 (ETDE-mf–0702833) **Compact car: Drive concept 1990. Final report.** Ingenieurgesellschaft fuer Aggregatetechnik und Verkehrsfahrzeuge m.b.H. (IAV), Berlin (Germany, F.R.); Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). Apr 1987. 96p. (In German). Contract BMFT TV 8475 7. Order Number DE90702833/JAW. Available from NTIS (US Sales Only), PC A05/MF A01.

The aim of the research project was to develop a low emission and fuel saving drive concept for a compact car. The requirements of private and business use in towns are to be met. The targets of development aimed at include extremely low fuel consumption, low emission of harmful substances, extremely low external noise. The technical development was directed to acceptable driving and suitable dimensions for fitting into a compact vehicle. Apart from the description of the project, data are given on the engine (2 cylinder Diesel DI engine, exhaust gas feedback), gearbox (5 speed momentum automatic gearbox), control of engine and gearbox and noise prevention measures. There are also reports on test rig experiments and experience of test operation with three vehicles of the Volkswagen Polo type. (HWJ).

47307 (PB–89-195788/XAB) **Engine combustion optimization by exhaust analysis. Final report, December 1986-July 1988.** Jahn, R.K.; Lee, D.J.; Cremean, S.P.; Bayless, R.A. Bailey Controls Co., Wickliffe, OH (USA). Jan 1989. 186p. Available from NTIS, PC A09/MF A01.

Portions of this document are not fully legible.

This report documents the application of an air/fuel ratio analyzer and trim control system to a two-cycle turbocharged compressor engine. The trim control strategy is based upon both oxygen and combustibles in the exhaust gases.

47308 **Engine and constant volume bomb studies of diesel ignition and combustion.** Ryan, T.W.; Callahan, T.J. 9p. Society of Automotive Engineers, Warrendale, PA (1988). (CONF-8810120–: Society of Automotive Engineers fuels and lubricants meeting and exposition, Portland, OR (USA), 10-13 Oct 1988).

Technical Paper 881626.

The importance of the ignition process is reflected in the fact that the only combustion property that is specified for diesel fuel is the ignition delay time as indicated by the cetane number. The objective of the work described in this paper was to determine the relationship between the ignition process as it occurs in an actual engine, to ignition in a constant volume combustion bomb. The ultimate goal is to develop a new procedure for rating the ignition and combustion quality of fuels for diesel engines. The short-term goal, and an interim step in the development effort, is to establish the bomb approach for determining cetane number.

47309 **Imaging of engine flow and combustion processes.** Schipperijn, F.W.; Nagasaka, R.; Sawyer, R.F.; Green, R.M. 15p. Society of Automotive Engineers, Warrendale, PA (1988). (CONF-8810120–: Society of Automotive Engineers fuels and lubricants meeting and exposition, Portland, OR (USA), 10-13 Oct 1988).

Technical Paper 881631.

The authors used the planar imaging of laser induced fluorescence from OH to mark the position of the propagating flame front in the engine. These results are compared to similar data obtained using a Mie scattering technique employed in an earlier study. In additional, they used laser induced fluorescence imaging of nitrogen dioxide to observed the intake valve flow in a flow stand and schlieren flow visualization to observe liquid fuel sprays, valve flow, and flame propagation. Both planar imaging of Mie scattering and schlieren photography were used to observe liquid fuel sprays and the qualitative aspects of fuel-air mixing during intake valve flow.

47310 Fiber-optic instrumented spark plug for measuring early flame development in spark ignition engines. Witze, P.O.; Hall, M.J.; Wallace, J.S. 13p. Society of Automotive Engineers, Warrendale, PA (1988). (CONF-8810120--: Society of Automotive Engineers fuels and lubricants meeting and exposition, Portland, OR (USA), 10-13 Oct 1988).

Technical Paper 881638.

An optical probe for measuring the motion and rate of growth of the early flame kernel in spark ignition engines is described. The probe consists of a standard spark plug with eight optical fibers installed in a ring at the base of the threaded region of the plug. The fibers collect the light emitted from the flame as it crosses the field of view of the fibers, and transmit the light to photomultiplier tubes. The time from ignition until detection of the flame is used to compute the average flame velocity in the direction of each fiber relative to the spark location. The real-time data acquisition system permits statistical analysis of cycle-by-cycle variations in the combustion rate.

47311 Comparison of computed and measured air motion in circular and square piston cups. McKinley, T.L.; Primus, R.J.; O'Rourke, P.J.; Butler, T.D. 21p. Society of Automotive Engineers, Warrendale, PA (1988). (CONF-8810120--: Society of Automotive Engineers fuels and lubricants meeting and exposition, Portland, OR (USA), 10-13 Oct 1988).

Technical Paper 881612.

A multi-dimensional flow code was used to predict the motoring air motion in an engine with both circular and square piston cups. The program solved the Navier-Stokes equations, supplemented with a κ-e turbulence model. The computational results were compared to recently published cycle-resolved LDV measurements for the same engine geometry. It was found that the predicted means radial and tangential velocity distributions agreed well with the measurements. The predicted and measured turbulence intensities were also in good agreement prior to TDC. However, during the expansion stroke the computed turbulence intensities were much higher than the experimental values. These differences were related to reverse squish effects shortly after TDC. The response of the model to the change from circular to square piston geometries was also in agreement with the experimental data.

47312 Coal-fueled diesels. McMillian, M.H. (U.S. Dept. of Energy, Morgantown Energy Technology Center, Morgantown, WV (US)); Webb, H.A. pp. 74 of Coal-fueled diesel engines. McMillan, M.H. Webb, H.A American Society of Mechanical Engineers, New York, NY (1989). (CONF-8901106--: Coal fueled diesel engines, Houston, TX (USA), 22-25 Jan 1989).

The U.S. Department of Energy (DOE) Office of Fossil Energy has sponsored research in the area of coal-fueled diesel engines since the late 1970's. The program began as an exploratory effort and has grown into a proof-of-concept program that includes several major medium speed diesel engine manufacturers. Those manufacturers have identified the utility, industrial cogeneration, and transportation markets as areas in which expensive clean distillate fuel may be displaced by low-cost, domestically abundant coal. Because of notable success in early projects of the coal-fueled diesel program, the DOE's Morgantown Energy Technology Center (METC) recently expanded the program with the award of contract for two 5-year, proof-of-concept engine development projects and one proof-of-principle project.

47313 Cooper-bessemer coal-fueled engine system. Rao, A.K. (Cooper-Bessemer Reciprocating, Grove City, PA (US)); Wilson, R.P. Jr.; Balles, E.N.; Mayville, R.A.; McMillan, M.H.; Kimberley, J.A. pp. 74 of Coal-fueled diesel engines. McMillan, M.H. Webb, H.A American Society of Mechanical Engineers, New York, NY (1989). (CONF-8901106--: Coal fueled diesel engines, Houston, TX (USA), 22-25 Jan 1989).

The current outlook on the overall economics of coal diesel power is presented, indicating that CWS processing cost dominates the question of economic feasibility. A description of the coal-tolerant fuel injection system development is also given. Wear results indicate that nozzle erosion is the critical element in extending the duration of continuous engine operation. Substantial nozzle wear was observed in just two hours of CWS operation. The ash content of the coal was found to affect the wear rate of the ring set as well as the nozzle tip.

47314 Progress on the investigation of coal-water-slurry fuel combustion in a medium-speed diesel engine. Hsu, B.D. (GE Research and Development Center, Pittsburgh, PA (US)); Leonard, G.L.; Johnson, R.N. pp. 74 of Coal-fueled diesel engines. McMillan, M.H. Webb, H.A American Society of Mechanical Engineers, New York, NY (1989). (CONF-8901106--: Coal fueled diesel engines, Houston, TX (USA), 22-25 Jan 1989).

Coal-water-slurry (CWS) engine tests designed to evaluate a new accumulator-based injection system are described in this paper. The new injection system was found to improve CWS burnout considerably at both full and part engine loads. The peak cylinder firing pressure when operating with CWS was no higher than when operating with diesel oil. These data demonstrate the improved engine performance that can be achieved with the accumulator-based injection system.

3303 Electric-powered Systems

Refer also to citation(s) 47263

47315 (PB-89-169510/XAB) **Reluctance motors in efficient variable-speed drive systems. Special report.** Kroeninger, H. Council for Scientific and Industrial Research, Pretoria (South Africa). National Electrical Engineering Research Inst. Mar 1987. 41p. (CSIR-SR-ELEK-308). Available from NTIS, PC EE05/MF E05.

North American Continent sales only.

This paper reviews the development of electrical machines of the reluctance type over the past twenty years. Reluctance machines are grouped into two broad categories, viz the AC reluctance machine with magnetically coupled stator phases, and the DC, or switched-reluctance machine with magnetically decoupled stator poles.

3307 Emission Control

Refer also to citation(s) 47306

47316 (PB-89-170211/XAB) **MOBILE4 emission factor model: source code (one version mixed case, one version upper case), input files for example runs, and high-altitude area I/M credits (for microcomputers). Model.** Newell, T.P.; Parsons, R. Environmental Protection Agency, Ann Arbor, MI (USA). Emission Control Technology Div. 1 Mar 1989. vp. Available from NTISCP D99.

For system on magnetic tape, see PB-89-170203. The software is contained on 5 1/4-inch diskettes, double density (360K), compatible with the IBM PC microcomputer. The diskettes are in the ASCII format. Price includes documentation, PB-89-164271.

MOBILE4 is a computer program that calculates emission factors for hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx) from highway motor vehicles. MOBILE4 calculates emission factors for eight individual vehicle types, in two regions of the country (low and high altitude). The emission factors depend on various conditions such as ambient temperature, fuel volatility, speed, and mileage-accrual rates. MOBILE4 will estimate emission factors for any calendar year between 1960 and 2020 inclusive. The 20 most recent model years are considered in operation in each calendar year. MOBILE4 supersedes MOBILE3. Relative to MOBILE3, MOBILE4 incorporates several new options, calculating methodologies, emission-control regulations, and internal program designs.

Software Description: The software is written in the FORTRAN language for use on an IBM PC or compatible machines using MS-DOS operating system. It requires a minimum of 920K of memory.

3308 Alternative Fuels

Refer also to citation(s) 46826, 46884, 47021, 47028, 47101, 47305, 47307, 47312, 47313, 47314

47317 (ORNL/FTR–3136) **[USDOE's federal methanol fleet report to the international symposium on alcohol fuels]: Foreign trip report, November 10, 1988–November 23, 1988.** McGill, R.N. Oak Ridge National Lab., TN (USA). 8 Dec 1988. 15p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE89017478/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler attended the 8th international symposium on alcohol fuels in Tokyo, Japan, and presented a paper on results from the Department of Energy's Federal Methanol Fleet. Considerable progress has been made in the engine technology for alcohol fuels in the two years since the last symposium. Flexible-fuel vehicles are prominent in new demonstrations, and methanol-fueled diesel engines are being used in a number of heavy-duty vehicle applications. Environment and urban air quality considerations have become the impetus for continued development of alcohol-fueled vehicle technology in the absence of demonstrated economic advantages for alcohols. Following the symposium, the traveler participated in an International Energy Agency (IEA) committee meeting on alcohol fuels, also in Tokyo. Participating countries were Canada, Japan, Italy, Sweden, and the USA; observers were present from Finland and the Federal Republic of Germany. In this meeting, progress on three annexes (studies) was presented and discussed, and the terms for continuation of those annexes were discussed. All three annexes are being continued, and further progress will be presented at the next committee meeting in June 1989 at Vancouver, Canada.

47318 (PB–89-195820/XAB) **Dedicated low-pressure natural gas-fueled vehicle baseline assessment. Task 3 topical report on light-duty vehicles. Topical report, January 1987-January 1989.** Biederman, R.T.; Arnold, J.A.; Blazek, C.F. Institute of Gas Technology, Chicago, IL (USA). Jan 1989. 118p. Available from NTIS, PC A06/MF A01.

This study defines a dedicated natural gas-fueled vehicle system that best incorporates all features of the low-pressure natural gas storage system being developed. Cost sensitivity analyses are presented for 250, 100, and 25 vehicle fleets. These analyses are useful in assessing the feasibility of individual fleet applications under a variety of possible scenarios. These scenarios are approached using ranges to describe the critical parameters involved in the analysis, such as vehicle cost premium, fuel cost differential, annual mileage, O&M costs, and capital costs.

35 ARMS CONTROL

47319 (AD-A–207375/7/XAB) **Soviet concepts of ballistic missile defense. Master's thesis.** Seavey, K.P. Naval Postgraduate School, Monterey, CA (USA). Jun 1988. 116p. Available from NTIS, PC A06/MF A01.

This thesis characterizes the Soviet concept of ballistic missile defense (BMD) in order to better understand and predict future Soviet BMD decision making. The Soviet concept of BMD is fundamentally different from that in the West. Soviet BMD is clearly an integral component of a much larger Soviet strategic defense effort which consists of strategic air defense as well as passive measures, such as mobility, deep underground command and control facilities, and civil defense. As the Soviet military literature demonstrates, Soviet strategic air defense encompasses defense against a continuum of threats – from aircraft to ballistic missiles to satellites to 'space-strike weapons'. Soviet strategic air defense weapons therefore appear optimized to counter a wide range of airborne threats. In the Soviet view, surface-to-air missiles may be a primary tactical BMD weapon. Additionally, Soviet strategic BMD weapons may be a primary Soviet anti-satellite weapon. Furthermore, manned space platforms play a particularly significant role in Soviet thinking about the future of BMD and space warfare.

3501 Policy, Negotiations, and Legislation

47320 (AD-A–207373/2/XAB) **Intermediate-range nuclear forces (INF) treaty: History of an illusion.** Dallas, M.D. Army War Coll., Carlisle Barracks, PA (USA). 1 Mar 1989. 32p. Available from NTIS, PC A03/MF A01.

Availability: Document partially illegible.

The purpose of this paper is to examine the Intermediate-Range Nuclear Force (INF) Treaty in historical perspective. The thesis of the paper is that the treaty is an illusion. It is an illusion that promotes the idea that security can be achieved exclusively through arms control, at the expense of balanced and diverse forces across the entire spectrum of deterrence. Although the treaty has been fully ratified, and U.S and Soviet officials have begun the process of destroying launchers, debate still rages in NATO capitals over the treat's impact on alliance security and cohesion. This paper begins with a discussion of the evolution of NATO's deterrent strategy. It continues with a chronology of events leading to the signing of the treaty by President Reagan and General Secretary Gorbachev on December 8, 1987. The paper assesses the military and political impact of the treaty and ends with possible implications for NATO's future and recommendations for further arms control negotiations. The paper concludes that the treaty has not achieved what its supporters claim. In fact the treaty is an arms-control agreement that: (1) is not remotely related to its original purpose; (2) has reinforced NATO military inferiority; and (3) may have laid the groundwork for the unraveling of the Atlantic Alliance.

3502 Proliferation

47321 (AD-A–207339/3/XAB) **Proliferation of chemical weapons: putting the genie back in the bottle. Study project.** Weekly, T.M. Army War Coll., Carlisle Barracks, PA (USA). 24 Feb 1989. 70p. Available from NTIS, PC A04/MF A01.

Following the introduction of gas warfare in World War I, there developed a set of restraints which were effective in preventing the use of toxic chemical agents in World War II. The prolonged Korean and Vietnam conflicts were fought, again without resort to toxic chemical weapons. Recently, however, there has been a breakdown of the traditional restraints which were effective for fifty years in preventing chemical warfare. This study examines the traditional restraint system that evolved after World War I and extrapolates that framework into the modern era to determine what has changed to render the traditional restraints ineffective today. From this analysis, a model is derived for an effective chemical weapons protocol, and a strategy is proposed for worldwide chemical disarmament.

3503 Verification

Refer also to citation(s) 47916

47322 (K/ITP–290) **A methodology for identifying, evaluating, and controlling the incremental risk of inadvertent sensitive information disclosure during on-site verification inspections at US facilities.** Swindle, D.W. Jr.; Brenner, L.M. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA). Aug 19[illegible]. 9p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OT21400. (CONF-8908141–2: U.S. Department of Energy conference on technology research and development for arms control verification, Los Alamos, NM (USA), 29-31 Aug 1989). Order Number DE89016878/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

From both the standpoints of national security impact and commercial advantage, on-site arms control agreement verification inspections pose serious concerns because of the possibility of inadvertent sensitive information disclosure to foreign inspectors. Thus, need has been satisfied most recently in connection with the United States' offer to permit the International Atomic Energy Agency (IAEA) to carry out on-site nuclear materials safeguards inspections at the Portsmouth Gas Centrifuge Enrichment Plant. An

approach to identifying, evaluating, and minimizing the risk of inadvertent compromise of sensitive information was used and has proved to be most effective. It should be equally applicable to quantifying the risk of disclosure during on-site inspections for arms control verifications.

36 MATERIALS

47323 (CONF-8409210–, pp. 9-35) **Purposes of the assessment.** Eberhardt, J.J. (Dept. of Energy, Washington, DC (USA)). Oak Ridge National Lab., TN (USA); Texas A and M Univ., College Station, TX (USA). Dept. of Chemistry. 1984. From Texas A and M symposium on theory, modeling and instrumentation for materials design; College Station, TX (USA); 17-19 Sep 1984. In *Theory, modeling and instrumentation for materials by design. Proceedings of workshop.* Order Number DE89007940/JAW. Available from NTIS, PC A99/MF A01.

This workshop ponders the question, Is now a propitious time to start a directed, applied research program to design materials from first principles? The paper describes the research efforts underway in the Energy Conservation and Utilization Technologies (ECUT) program. The objectives of ECUT are to monitor advances and evaluate them for applicability to energy conservation; conduct exploratory development on conservation concepts; establish feasibility of concepts; expand technology base; ensure continual flow of information on conservation advances; and encourage identification of research needs. It is concluded that ECUT strengthens the link between basic researchers and end-users; fulfills a need in the technology transfer process; and develops analytical tools, data, and innovative concepts for the end-users, but must be guided by the needs of the end-users.

47324 (CONF-8409210–, pp. 37-62) **How can materials theory benefit from supercomputers and vice versa?.** Phillips, J.C. (AT and T Bell Labs., Murray Hill, NJ (USA)). Oak Ridge National Lab., TN (USA); Texas A and M Univ., College Station, TX (USA). Dept. of Chemistry. 1984. From Texas A and M symposium on theory, modeling and instrumentation for materials design; College Station, TX (USA); 17-19 Sep 1984. In *Theory, modeling and instrumentation for materials by design. Proceedings of workshop.* Order Number DE89007940/JAW. Available from NTIS, PC A99/MF A01.

This paper discusses atomic scale physics and chemistry in relation to materials science. The author comments on the opportunities for numerical simulation that have developed in recent years with supercomputers. Several examples are described that are treated by computer simulations: chemical reactions in solutions; the formation of glass; and the vector percolation problem.

47325 (CONF-8409210–, pp. 101-121) **Relationship between ab initio and semiempirical theories of electronic structure.** Freed, K.F. (Univ. of Chicago, IL (USA)). Oak Ridge National Lab., TN (USA); Texas A and M Univ., College Station, TX (USA). Dept. of Chemistry. 1984. From Texas A and M symposium on theory, modeling and instrumentation for materials design; College Station, TX (USA); 17-19 Sep 1984. In *Theory, modeling and instrumentation for materials by design. Proceedings of workshop.* Order Number DE89007940/JAW. Available from NTIS, PC A99/MF A01.

One of the important components of this conference is the discussion of electronic structure of materials. Most of you are aware that theories of electronic structures come in two varieties, the ab initio and the semiempirical approaches. In order to understand this division, the author begins with a comparison of the two approaches in something like a debate format. He then takes up the questions of whether there is a bridge between ab initio and semiempirical theories and how one can convert the full Schrodinger equation with an infinite basis into one involving a small number of valence orbitals and still maintain chemical accuracy.

47326 (CONF-8409210–, pp. 585-612) **Discussion of theoretical techniques in quantum chemistry and solid state physics.** Herman, F. (IBM Research Lab., San Jose, CA (USA)). Oak Ridge National Lab., TN (USA); Texas A and M Univ., College Station, TX (USA). Dept. of Chemistry. 1984. From Texas A and M symposium on theory, modeling and instrumentation for materials design; College Station, TX (USA); 17-19 Sep 1984. In *Theory, modeling and instrumentation for materials by design. Proceedings of workshop.* Order Number DE89007940/JAW. Available from NTIS, PC A99/MF A01.

The discussions by each panel member are presented in full. Then the chairman summarizes the conclusions and recommendations on the following topics: artificial versus natural intelligence; alternative approaches and competition; computer assisted molecular engineering; and computer modeling in an industrial environment.

3601 Metals and Alloys

Refer also to citation(s) 46794, 46827, 46828, 46829, 47107, 47118, 47165, 47289, 47414, 47416, 47717, 47725, 47732, 48176, 48280, 48496, 48522, 48525, 48536, 48697

47327 (AD-A–205632/3/XAB) **Liquid Dynamic Compaction of Fe-Nd-B permanent magnets. Final report, 1 September 1984-31 December 1988.** Grant, N.J.; O'Handley, R.C. Massachusetts Inst. of Tech., Cambridge, MA (USA). Feb 1989. 7p. Available from NTIS, PC A02/MF A01.

The purpose of this work was to gain an improved understanding of the critical parameters of the rapid solidification process known as Liquid Dynamic Compaction (LDC). This was to be accomplished by a series of experiments on an important alloy system, Fe-Nd-B, known to show property instabilities with small variations in processing conditions. As a secondary objective it was considered desirable if, in the course of the program, permanent magnets with improved properties were developed. Both of these objectives were met.

47328 (AD-A–207647/9/XAB) **Recrystallization and respheroidization of tungsten grains in a tungsten-heavy alloy. Final report.** Dowding, R.J. Army Materials Research Agency, Watertown, MA (USA). Materials Technology Lab. Apr 1989. 23p. (MTL-TR–89-31). Available from NTIS, PC A03/MF A01.

Refinement of the microstructure of tungsten-heavy alloys, specifically 90 W-7 Ni-3 Fe, was achieved through heavy cold working followed by a heat treatment that recrystallized and respheroidized the tungsten grains. Hydrostatic extrusion of the alloy to reductions of area of 83% and 96% followed by isothermal annealing gives fine, spherical tungsten grains imbedded within the nickel-iron matrix. The finest grain size achieved was 15 microns for the 96% extrusion when subjected to an anneal at 1300 C for 2 hours. The apparent activation energy for the process was found to be 530 kJ/mole. This value indicates that volume diffusion is significant in respheroidizing the grains.

47329 (ANL–80-120-Rev.1) **Polishing methods for metallic and ceramic transmission electron microscopy specimens: Revision 1.** Kestel, B.J. Argonne National Lab., IL (USA). Mar 1986. 66p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE89016686/JAW. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

In recent years, the increasing sophistication of transmission electron microscope (TEM) studies of materials has necessitated more exacting methods of specimen preparation. The present report describes improved equipment and techniques for electropolishing and chemically polishing a wide variety of specimens. Many of the specimens used in developing or improving the techniques to be described were irradiated with heavy ions such as nickel or vanadium to study radiation damage. The high cost of these specimens increased the need for reproducible methods of initial preparation postirradiation processing, and final thinning for TEM examination. A technique was also developed to salvage specimens that had previously been thinned but were unusable for various reasons. Jet polishing is, in general, the method of choice for surface polishing, sectioning, and thinning. The older beaker electropolishing method is included in this report because it is inexpensive and simple, and gives some insight into how the more recent methods were developed.

47330 (BNL–42866) **Observation of long-range ferromagnetic order in the heavy-fermion compuound $URu_{1.2}Re_{0.8}Si_2$ by neutron scattering.** Torikachvili, M.S.; Rebelsky, L.; Motoya, K.; Shapiro, S.M.; Dalichaouch, Y.; Maple, M.B. Brookhaven National Lab., Upton, NY (USA). 1989. 10p. Sponsored by DOE/ER;NSF.

DOE Contract AC02-76CH00016;FG03-86ER45230. DMR-84-11839. (CONF-890953–2: International conference on the physics of highly correlated electron systems, Santa Fe, NM (USA), 11-15 Sep 1989). Order Number DE89017621/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

We have performed a neutron scattering study of the heavy-fermion compound $URu_{1.2}Re_{0.8}Si_2$, in order to verify the occurrence of long-range ferromagnetic order. This study consisted of measurements of elastic, inelastic, and polarized neutron scattering, measurement of low-angle critical scattering, and the determination of the temperature dependence of the order parameter. We found a sharp peak in the critical scattering at ≈ 30 K for the wavevector q = 0.08 $Å^{-1}$; and an enhancement of the intensity at the position of the [101] nuclear Bragg reflection below the Curie temperature. These measurements suggest the occurrence of long-range magnetic order. The value of the ordered moment is estimated to be ≈ 0.53 μ_B at 10 K. 17 refs., 3 figs.

47331 (BNL–43052) **Electronic structure of transition metal alloys and intermetallics: Charge transfer and its inplications for Moessbauer effect measurements.** Watson, R.E.; Davenport, J.W.; Weinert, M.; Fernando, G.W. Brookhaven National Lab., Upton, NY (USA). 1989. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-890933–2: International conference on the applications of the Mossbauer effect (ICAME '89), Budapest (Hungary), 4-8 Sep 1989). Order Number DE89017603/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Moessbauer effect provides several measures of charge transfer and bonding effects in compounds, namely in its measured quadrupole fields and isomer shifts. The isomer shifts offer a unique sampling of such transfer and these shifts will be juxta-posed against other experimental measures. Charge transfer estimates obtained in electronic structure calculations for transition metal alloys are inspected in light of known isomer shift trends and the competing contributions to "charge transfer" elucidated. 5 refs., 8 figs.

47332 (CEA-CONF–9455) **^{170}Yb Moessbauer study of the heavy-electron pnictides YbP, YbAs and YbSb.** Bonville, P.; Hodges, J.A.; Imbert, P.; Jehanno, G.; Marimon, J.B. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF). 1988. 6p. (CONF-880704–: 6. international conference on crystal-field effects and heavy-fermion physics (ICCHFP-6), Frankfurt am Main (Germany, F.R.), 18-21 Jul 1988). Order Number DE90701464/JAW. Available from NTIS (US Sales Only), PC A02/MF A01.

^{170}Yb Moessbauer measurements on the heavy-electron compounds YbP, YbAs, and YbSb have probed the competition between RKKY exchange interactions and Kondo hybridisation. Magnetic ordering occurs below T_N~0.5K with reduced magnetic moments; the RKKY exchange interaction was measured and found to be much greater than K_BT_N.

47333 (CEA-CONF–9456) **Rare earth Moessbauer absorption in $ErPd_2Sn$ and $YbPd_2Sn$.** Hodges, J.A.; Jehanno, G. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Inst. de Recherche Fondamentale (IRF). 1988. 9p. (CONF-880705–: International conference on magnetism (ICM '88), Paris (France), 25-29 Jul 1988). Order Number DE90701462/JAW. Available from NTIS (US Sales Only), PC A02/MF A01.

Rare earth magnetic order and superconductivity are known to coexist in $ErPd_2Sn$ and $YbPd_2Sn$. From rare earth Mossbauer measurements, we obtain the saturated magnetic moments which show distributions around mean values of 5.7 μ_B (Er) and 1.6 μ_B (Yb) and find that the rare earth local symmetry is not cubic.

47334 (CEA-CONF–9484) **Magnetic order and magnetic behavior of the polished amorphous eutectic alloys $Tb_{65}Cu_{35}$ and $Er_{69.5}Cu_{30.5}$ - influence of a magnetic field.** Boucher, B.; Sanquer, M.; Tourbot, R.; Chieux, P. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service de Physique du Solide et de Resonance Magnetique. 1988. 8p. (CONF-880705–: International conference on magnetism (ICM '88), Paris (France), 25-29 Jul 1988). Order Number DE90701463/JAW. Available from NTIS (US Sales Only), PC A02/MF A01.

Susceptibility, magnetization and small angle neutron scattering measurements have been made at various temperatures on polished amorphous alloys. The influence of applied magnetic field is described in terms of magnetic domains. The evolution with temperature of the magnetic order is discussed. The comparison between Tb and Er alloys shows two different behaviors.

47335 (CONF-8409210–, pp. 123-150) **Ab initio calculations of materials properties.** Louie, S.G. (Univ. of California, Berkeley (USA)). Oak Ridge National Lab., TN (USA); Texas A and M Univ., College Station, TX (USA). Dept. of Chemistry. 1984. DOE Contract AC03-76SF00098. From Texas A and M symposium on theory, modeling and instrumentation for materials design; College Station, TX (USA); 17-19 Sep 1984. In *Theory, modeling and instrumentation for materials by design. Proceedings of workshop.* Order Number DE89007940/JAW. Available from NTIS, PC A99/MF A01.

It has become possible to do calculations on real materials with quite good accuracy in the last few years from first principles. The author illustrates this by giving several examples, mostly from some recent work that he has done at Berkeley. Ab initio electronic structure calculations do not require empirical input - that is, the only input are the atomic numbers and masses of the constituent elements. From these calculations, one would then obtain quantities such as equilibrium crystal structures and lattice constants, bulk moduli, shear moduli, cohensive energies, vibrational properties, and even phonon-phonon and electron-phonon interaction parameters. This development has given rise to many exciting possibilities. For example, it is now possible to predict new materials and their properties and to study the electronic and atomic structures of surfaces, interfaces, and defects. One can also investigate the phase stability of systems under extreme conditions of pressures and temperatures.

47336 (CONF-8409210–, pp. 151-172) **Metals in intimate contact.** Smith, J.R. (General Motors Research, Warren, MI (USA)); Ferrante, J. Oak Ridge National Lab., TN (USA); Texas A and M Univ., College Station, TX (USA). Dept. of Chemistry. 1984. From Texas A and M symposium on theory, modeling and instrumentation for materials design; College Station, TX (USA); 17-19 Sep 1984. In *Theory, modeling and instrumentation for materials by design. Proceedings of workshop.* Order Number DE89007940/JAW. Available from NTIS, PC A99/MF A01.

The authors consider the situation where two metal surfaces are in such close contact that electron wave functions from the two metals can overlap. The electronic structure and total energy is computed as a function of separation between the surfaces for all combinations of the simple metals Al (111), Zn (0001), Mg (0001), and Na (110). Significant electron transfer and/or rearrangement was found. The range of relatively strong bonding was about one interplanar spacing. The dominant attractive energy component is the electron exchange-correlation energy. The kinetic energy component is the dominant repulsive component at small separations but becomes attractive at larger separations. Several analogies are drawn between the bimetallic and molecular bond. In fact, a universality is discovered for the shape of the total energy as a function of distance between atoms. Finally, the bimetallic interface between simple metals is compared with that between transition metals. The transition metal localized orbitals lead to a more localized electronic rearrangement at the interface.

47337 (CONF-8409210–, pp. 173-195) **Lateral interactions in adsorption: Revelations from phase transitions.** Einstein, T.L. (Univ. of Maryland, College Park (USA)). Oak Ridge National Lab., TN (USA); Texas A and M Univ., College Station, TX (USA). Dept. of Chemistry. 1984. DOE Contract AS05-79ER10427;FG05-84ER45071. From Texas A and M symposium on theory, modeling and instrumentation for materials design; College Station, TX (USA); 17-19 Sep 1984. In *Theory, modeling and instrumentation for materials by design. Proceedings of workshop.* Order Number DE89007940/JAW. Available from NTIS, PC A99/MF A01.

The paper discusses how one can get useful information to characterize a material based on phase transitions. In particular, one can learn a great deal about lateral interactions, that is, interactions either between adsorbed atoms sitting on a surface or between surface atoms in a surface that is reconstructing. Some other things revealed by phase transitions are some information on binding sites

and some idea of defects such as poisons, vacancies, or steps. The general model for this discussion is the lattice gas model, and the calculational techniques the author uses are Monte Carlo and phenomenological renormalization, also called transfer matrix scaling, which is a much quicker calculation than Monte Carlo. The sorts of things one calculates are phase boundaries, correlation functions, and then structure factors, which are essentially what one measures in a scattering experiment. The author also briefly discusses critical exponents, which turn out to have useful information about material properties as well as having a lot of intrinsic theoretical interest.

47338 (CONF-8409210–, pp. 197-214) **Quantum model of thermal desorption and laser stimulated desorption.** Jedrzejek, C. (Texas A and M Univ., College Station (USA)). Oak Ridge National Lab., TN (USA); Texas A and M Univ., College Station, TX (USA). Dept. of Chemistry. 1984. From Texas A and M symposium on theory, modeling and instrumentation for materials design; College Station, TX (USA); 17-19 Sep 1984. In *Theory, modeling and instrumentation for materials by design. Proceedings of workshop.* Order Number DE89007940/JAW. Available from NTIS, PC A99/MF A01.

A short review of microscopic quantum models describing the dynamics governing thermal desorption and laser-induced desorption processes is presented. The importance of including broadening of zero-order energy levels of underlying Hamiltonians is stressed. Prospects of extending the thermal desorption model, valid for weakly bound systems, to describe chemisorption and multi-stage desorption are discussed.

47339 (CONF-8409210–, pp. 215-235) **Extended fine structure in appearance potential spectroscopy as a probe of solid surfaces.** Laramore, G.E. (Univ. of Washington Hospital, Seattle (USA)). Oak Ridge National Lab., TN (USA); Texas A and M Univ., College Station, TX (USA). Dept. of Chemistry. 1984. From Texas A and M symposium on theory, modeling and instrumentation for materials design; College Station, TX (USA); 17-19 Sep 1984. In *Theory, modeling and instrumentation for materials by design. Proceedings of workshop.* Order Number DE89007940/JAW. Available from NTIS, PC A99/MF A01.

The author discusses easier ways to obtain a certain discrete amount of experimental data than having to go through complex calculations requiring floating point accelerator processes and large computer systems. He starts with the example of the effect a single isolated impurity has on the electronic core levels and valence levels in an otherwise ordered solid. The core level excitation process is illustrated schematically and mathematically. Renormalization of LEED data on vanadium is done. Phase factors for aluminum oxide clusters are also calculated.

47340 (CONF-8409210–, pp. 237-241) **Structural aspects of band offsets at heterojunction interfaces.** Kraut, E. (Rockwell International, Thousand Oaks, CA (USA)). Oak Ridge National Lab., TN (USA); Texas A and M Univ., College Station, TX (USA). Dept. of Chemistry. 1984. From Texas A and M symposium on theory, modeling and instrumentation for materials design; College Station, TX (USA); 17-19 Sep 1984. In *Theory, modeling and instrumentation for materials by design. Proceedings of workshop.* Order Number DE89007940/JAW. Available from NTIS, PC A99/MF A01

The concept of materials by design suggests the possibility of creating artificial materials having physical properties which are superior to those which commonly occur in nature. For example, layered semiconductor structures or superlattices have been shown to have unique electronic and optical properties. The electronic states associated with such layered semiconductors can be obtained by diagonalizing large banded matrices. The size of these matrices depends on the number of atoms per unit cell and the number of orbitals per atom. New and emerging computer architectures are particularly effective in handling such banded matrices and new algorithms have been developed to exploit vector and parallel processing in this context. However, increased computer power is not the whole answer as a comparison of theoretically predicted and experimentally observed hetero-junction energy band discontinuities shows. In this case, an increase in computer speed and memory size is not likely to produce a corresponding improvement in the agreement between theory and experiment because the atomic scale details of interface geometry and composition cannot be described sufficiently accurately yet.

47341 (CONF-8409210–, pp. 273-280) **Wavefunctions and charge densities for defects in solids: A success for semiempirical theory.** Shang Yuan Ren (Univ. of Science and Technology of China, Hefei). Oak Ridge National Lab., TN (USA); Texas A and M Univ., College Station, TX (USA). Dept. of Chemistry. 1984. From Texas A and M symposium on theory, modeling and instrumentation for materials design; College Station, TX (USA); 17-19 Sep 1984. In *Theory, modeling and instrumentation for materials by design. Proceedings of workshop.* Order Number DE89007940/JAW. Available from NTIS, PC A99/MF A01.

The isotropic and anisotropic parts of deep impurity wavefunctions are predicted as functions of energy E for substitutional, A_1- and T_2- symmetric sp^3-bonded deep levels in Si, GaP, and GaAs, using an extended and modified version of Hjalmarson et al's simple and global deep defect models. The wavefunctions of deep levels are host like and virtually independent of the impurity responsible for the deep level. Some basic physics of deep defect states in semiconductors is discussed using this theory.

47342 (CONF-8409210–, pp. 281-327) **Empirical methods for predicting the phase diagrams of intermetallic alloys.** Chelikowsky, J.R. (Exxon Research and Engineering Co., Annandale, NJ (USA)). Oak Ridge National Lab., TN (USA); Texas A and M Univ., College Station, TX (USA). Dept. of Chemistry. 1984. From Texas A and M symposium on theory, modeling and instrumentation for materials design; College Station, TX (USA); 17-19 Sep 1984. In *Theory, modeling and instrumentation for materials by design. Proceedings of workshop.* Order Number DE89007940/JAW. Available from NTIS, PC A99/MF A01.

This paper presents a global picture of alloy formation. The motivation for this goal is establish some guidelines or rules for understanding the chemical bond in alloys. Here one wants to extract only the essential features of what happens in the alloying process and not worry about the specific details of a particular binary alloy phase diagram. The author addresses several questions in this talk. For example, can we predict whether an ordered phase will exist for a given alloy system? What is the structure of the phase? What is the stoichiometry? What is the melting point of the phase? He also addresses the question of solubilities and surface segregation, but only briefly.

47343 (CONF-8409210–, pp. 329-380) **Theoretical considerations regarding impurities in silicon and the chemisorption of simple molecules on nickel.** Messmer, R. (General Electric Co., Schenectady, NY (USA)). Oak Ridge National Lab., TN (USA); Texas A and M Univ., College Station, TX (USA). Dept. of Chemistry. 1984. From Texas A and M symposium on theory, modeling and instrumentation for materials design; College Station, TX (USA); 17-19 Sep 1984. In *Theory, modeling and instrumentation for materials by design. Proceedings of workshop.* Order Number DE89007940/JAW. Available from NTIS, PC A99/MF A01.

The paper begins with a discussion of molecular adsorbates on metals, in particular, the importance of correlation effects in understanding chemisorption. The author's calculations are compared with a series of experimental observations rather than just one. The author uses the chemisorption of nitrogen on nickel as an example. The author then tackles the problem of point defects in silicon, using nitrogen, phosphorus, oxygen, and sulfur as the substitutional impurities.

47344 (CONF-8409210–, pp. 381-391) **Improved Kohn-Sham exchange potential.** Antoniewicz, P.R. (Univ. of Texas, Austin (USA)); Kleinman, L. Oak Ridge National Lab., TN (USA); Texas A and M Univ., College Station, TX (USA). Dept. of Chemistry. 1984. DOE Contract FG05-84ER45064. From Texas A and M symposium on theory, modeling and instrumentation for materials design; College Station, TX (USA); 17-19 Sep 1984. In *Theory, modeling and instrumentation for materials by design. Proceedings of workshop.* Order Number DE89007940/JAW. Available from NTIS, PC A99/MF A01.

The Kohn-Sham exchange potential may be written, exact to first order in $\rho(K)/\rho_0$, $V_x^{KS} = -3/2\ (3/\pi)^{1/3}\ \rho_0^{-2/3}\ \Sigma_{K-vector'}\rho(K\{$

vector})F(K)e$^{IK\{vector\}\ xr\{vector\}}$. The authors here evaluate the universal function $F(K/k_F)$ for all K/k_F and find large corrections to the local density approximation which should result in much improved values for semiconductor energy gaps.

47345 (CONF-8409210–, pp. 393-428) **Structural stability calculations for films and crystals.** Trickey, S.B. (Univ. of Florida, Gainesville (USA)). Oak Ridge National Lab., TN (USA); Texas A and M Univ., College Station, TX (USA). Dept. of Chemistry. 1984. From Texas A and M symposium on theory, modeling and instrumentation for materials design; College Station, TX (USA); 17-19 Sep 1984. In *Theory, modeling and instrumentation for materials by design. Proceedings of workshop.* Order Number DE89007940/JAW. Available from NTIS, PC A99/MF A01.

The paper is primarily concerned with the structural stability of bulk crystals and their associated thin films under extreme conditions, for example, a pressure greater than 100 kilobars. The author presents some wavefunction methods that are an attempt to go beyond the density functional theory and discusses recent results on alternative molecular orbital wavefunctions for extended systems. Secondly, he discusses high-precision calculations on simple actual systems. The methodology used was Linear Combination of Gaussian type Orbitals; materials used were neon, aluminum, lithium, and beryllium.

47346 (CONF-8409210–, pp. 429-451) **Semiempirical molecular orbital modeling of catalytic reactions including promoter effects.** Blyholder, G.D. (Univ. of Arkansas, Fayetteville (USA)). Oak Ridge National Lab., TN (USA); Texas A and M Univ., College Station, TX (USA). Dept. of Chemistry. 1984. From Texas A and M symposium on theory, modeling and instrumentation for materials design; College Station, TX (USA); 17-19 Sep 1984. In *Theory, modeling and instrumentation for materials by design. Proceedings of workshop.* Order Number DE89007940/JAW. Available from NTIS, PC A99/MF A01.

The paper examines the role of semiempirical theories to furnish a conceptual framework. Some past, present and future calculations of importance to materials design and catalysis were discussed. The role of d orbitals as a reservoir for charge in bending HNiH has been illuminated. A precursor state for H_2 adsorption and a dissociation path for H_2 have been found. The d band density of states shifts even thought the d orbitals are not directly involved in the bonding. The paper illustrates why formyl formation is such a difficult step and shows some of the ways to make formyl intermediates more stable. These include alkali promotion and point out the need for future calculations on larger clusters. Computers are currently available with the capability to handle large clusters in semiempirical calculations. In the calculations the clusters are still so small that site effects due to cluster size still occur. A larger cluster in the calculations would help to discuss surface sites better. A semiempirical program should be developed that can be used easily by catalytic chemists in a large number of places to investigate their own systems and their own particular ideas about important additives and mechanisms. Catalytic chemists should have programs to use just as organic chemists now use all of the semiempirical methods available to them. While these calculational programs may be misused, they lead to ideas about new direction to investigate.

47347 (CONF-8906205–1) **Structure-property relationships as an aid in the rational design of β-$(ET)_2X$ organic superconductors.** Williams, J.M.; Wang, Hau H.; Kini, A.M.; Beno, M.A.; Geiser, U.; Schultz, A.J.; Carlson, K.D.; Ferraro, J.R.; Whangbo, Myung-Hwan. Argonne National Lab., IL (USA). [1989]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38;FG05-86ER45259. From NATO advanced study institute on lower-dimensional systems and molecular electronics; Spetses (Greece); 12-23 Jun 1989. Order Number DE89016912/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The organic electron-donor molecule ET, 1, has been the current central focus of research in organic superconductors because it forms numerous solid phases with anions, X^-, of which the β-$(ET)_2X$ materials, X = IBr_2^-, AuI_2^-, and I_3^-, are ambient pressure superconductors with T_c's = 2.8 K, 4.9 K, and 1.5 K (and 8 K at p > 0.5 kbar), respectively. The synthesis of these materials has been summarized in detail in the literature and is discussed in this report. 9 refs., 4 figs., 1 tab.

47348 (DLR-FB–89-33) **Threshold for fatigue crack propagation.** Castro, D.E. Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Koeln (Germany, F.R.). 1989. 104p. (In German). Order Number DE90702783/JAW. Available from NTIS (US Sales Only), PC A06/MF A01.

In the present work the influence of the loading-history on the threshold for fatigue crack propagation by the alloys Inconel 617 and Ti-6Al-4V was investigated. Measurements of the crack-opening stress intensity factor K_{op} were carried out in order to judge the influence of this parameter on ΔK_{th}. The results show that the threshold ΔK_{th} always exists independent of the prior loading-condition. The value of ΔK_{th} decreases with increasing ΔK and increasing maximal stress intensity factor K_{max} of the prior loading. The results are discussed in terms of crack-closure and changes of the microstructure in the plastic zone. (orig.) With 39 figs., 8 tabs., 81 refs.

47349 (DOE/CE/15412–T1) **The Meta-Lax method of stress reduction in welds: First quarterly report.** Welding Consultants, Inc., Columbus, OH (USA). 24 Jul 1989. 5p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-89CE15412. Order Number DE89016437/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The objective of this program is to study the ability of the Meta-Lax process to replace thermal treatments commonly employed during welded fabrication of metals. The energy saving offered by the Meta-Lax process result in a twofold manner. First, the only energy input required is the small amount of 110 volt household current necessary to run an electric motor which drives the vibrator. Secondly, the time required to accomplish the necessary effect is minimal compared to the time for an equivalent thermally-induced effect. 2 figs., 1 tab.

47350 (DOE/ER/13834–7) **Magnetic measurements of the transuranium elements: Progress report, January 1, 1989–December 31, 1989.** Nave, S.E. Tennessee Univ., Knoxville, TN (USA). Dept. of Physics and Astronomy. Sep 1989. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER13834. Order Number DE89017807/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This paper discusses magnetic properties of transuranium elements. In particular, californium fluorides, americium bromides, and curium alloys are discussed. (LSP)

47351 (DOE/NASA/16310–11) **Creep behavior of tungsten fiber reinforced niobium metal matrix composites.** Grobstein, T.L. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. [1989]. 17p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AI03-86SF16310. (NASA-TM–102307;CONF-890103–11: 6. symposium on space nuclear power systems, Albuquerque, NM (USA), 9-12 Jan 1989). Order Number DE89017743/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Tungsten fiber reinforced niobium metal matrix composites were evaluated for use in space nuclear power conversion systems. The composite panels were fabricated using the arc-spray monotape technique at the NASA Lewis Research Center. The creep behavior of W/Nb composite material was determined at 1400 and 1500 K in vacuum over a wide range of applied loads. The time to reach 1-percent strain, the time to rupture, and the minimum creep rate were measured. The W/Nb composites exceeded the properties of monolithic niobium alloys significantly even when compared on a strength to density basis. The effect of fiber orientation on the creep strength also was evaluated. Kirkendall void formation was observed at the fiber/matrix interface; the void distribution differed depending on the fiber orientation relative to the stress axis. A relationship was found between the fiber orientation and the creep strength. 10 refs., 16 figs.

47352 (FNAL-TM–1613) **Thermal conduction of SSC [Superconducting Super Collider] wire.** Kuchnir, M.; Tague, J.L. Fermi National Accelerator Lab., Batavia, IL (USA). Aug 1989. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-890701–3: International cryogenic materials conference, Los Angeles, CA (USA), 24-28 Jul 1989). Order Number DE89016710/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A method suitable for measuring the thermal conductivity of good thermal conductors at low temperatures was implemented. It successfully served its purpose: to detect the effect of doping with manganese the interfilament part of the copper matrix of the superconducting wire used in the magnets of the Superconducting Super Collider. It uses two heaters and one thermometer per sample reducing the accuracy requirement on the thermometers, automatically compensating for zero offsets and reducing the number of critical thermal contacts. Commercially available strain gauges are used as heaters. 3 refs., 2 figs.

47353 (INIS-mf–11515, pp. 72) **Calorimetric and magnetic properties in uranium -intermetallic compounds.** Pillmayr, N. (Technische Univ., Vienna (Austria). Inst. fuer Experimentalphysik); Hilscher, G.; Sechovsky, V.; Havela, L. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47354 (INIS-mf–11515, pp. 69) **Electron-positron annihilation rates in metals.** Sormann, H. (Technische Univ., Graz (Austria). Inst. fuer Kernphysik). Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47355 (INIS-mf–11515, pp. 70) **Thermophysical investigations of tungsten at high temperatures and pressures.** Jaeger, H. (Techn. Univ. Graz, Inst. fuer Experimentalphysik, Graz (Austria)); Kaschnitz, E.; Pottlacher, G. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47356 (INIS-mf–11515, pp. 70) **Unstable magnetic order in intermetallic compounds.** Wiesinger, G. (Technische Univ., Vienna (Austria). Inst. fuer Experimentalphysik); Hilscher, G.; Forsthuber, M.; Lehner, F. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47357 (INIS-mf–11515, pp. 71) **Spin fluctuations and weak itinerant ferromagnetism in $Y(Co_{1-x}Al_x)_2$ $(0,00 \leq x \leq 0,18)$.** Hilscher, G. (Technische Univ., Vienna (Austria). Inst. fuer Experimentalphysik); Forsthuber, M.; Pillmayr, N.; Hauser, R.; Wutte, D.; Yoshimura, K. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47358 (INIS-mf–11515, pp. 72) **Influence of fluctuations on the phase transformations in the superconductor.** Kolnberger, S. (Johannes Kepler Univ., Inst. fuer Theoretische Physik, Linz (Austria)); Folk, R. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47359 (INIS-SU–112) **Physics of radiation damages and radiation material science. Scientific-technical collection.** Voprosy atomnoj nauki i tekhniki. v. 5(47). Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Tsentral'nyj Nauchno-Issledovatel'skij Inst. Informatsii i Tekhniko-Ehkonomicheskikh Issledovanij po Atomnoj Nauke i Tekhnike. 1988. 72p. (BTs–23145). Order Number DE89018004/JAW. Available from NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS.

Individual papers are processed separately for the data base. (DLC)

47360 (INIS-SU–112, pp. 15-23) **Estimation of drift intensities of point defects based on recombination process.** Golubov, S.I. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Obninsk (USSR). Fiziko-Ehnergeticheskij Inst.); Konobeev, Yu.V. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Tsentral'nyj Nauchno-Issledovatel'skij Inst. Informatsii i Tekhniko-Ehkonomicheskikh Issledovanij po Atomnoj Nauke i Tekhnike. 1988. (In Russian). (BTs–23145). In *Physics of radiation damages and radiation material science. Scientific-technical collection.* Order Number DE89018004/JAW. Available from NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS.

Voprosy atomnoj nauki i tekhniki.; v. 5(47).

Recombination of points defects is shown to be sufficiently accurate taken into account when considering analytically sink intensity in irradiated metal. Besides dislocations preference to PIA the paper deals with preference of vacancy voids. Expressions for sink intensities are obtained to analyse reactor and accelerator data on swelling and microstructure of irradiated metals. Ratio of radii of point defects capture by dislocations, with the help of which it is extracted from experimental data for pure nickel irradiated by proper ions with high generation velocity of Frenkel pairs, is turned out to be the growing function of radiation temperature. 7 refs.; 2 tabs.

47361 (INIS-SU–112, pp. 7-10) **Annealing of radiation defects in region of 3 stage in nickel and in nickel-titanium alloy.** Arbuzov, V.L. (AN SSSR, Moscow (USSR). Inst. Fiziki Metallov); Davletshin, A.Eh.; Danilov, S.E.; Druzhkov, A.P.; Klotsman, S.M.; Zelenskij, V.F.; Neklyudov, I.M.; Petrusenko, Yu.T.; Reznichenko, Eh.A.; Sleptsov, A.N. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Tsentral'nyj Nauchno-Issledovatel'skij Inst. Informatsii i Tekhniko-Ehkonomicheskikh Issledovanij po Atomnoj Nauke i Tekhnike. 1988. (In Russian). (BTs–23145). In *Physics of radiation damages and radiation material science. Scientific-technical collection.* Order Number DE89018004/JAW. Available from NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS.

Voprosy atomnoj nauki i tekhniki.; v. 5(47).

Annealing of radiation defects after electron irradiation in nickel and in nickel-titanium alloy is investigated by the methods of resudual electric resistivity and annihilation of positrons. Vacancies are shown to migrate at the 3d stage of annealing, and impurity atoms of titanium are traps for vacancies and interstitial atoms and promote increased cluster-formation of vacancies in comparison with pure nickel. 9 refs.; 3 figs.

47362 (INIS-SU–112, pp. 24-27) **Combined implantation of carbon and nitrogen ions in molybdenum.** Kazdaev, Kh.R. (AN Kazakhskoj SSR, Alma-Ata (USSR). Inst. Yadernoj Fiziki); Akchulakov, M.T.; Abashina, A.V.; Bayadilov, E.M. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Tsentral'nyj Nauchno-Issledovatel'skij Inst. Informatsii i Tekhniko-Ehkonomicheskikh Issledovanij po Atomnoj Nauke i Tekhnike. 1988. (In Russian). (BTs–23145). In *Physics of radiation damages and radiation material science. Scientific-technical collection.* Order Number DE89018004/JAW. Available from NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS.

Voprosy atomnoj nauki i tekhniki.; v. 5(47).

The problem on the most probable bonds, which can be brought about between atoms of molybdenum, carbon, nitrogen under conditions of ion implantation, is investigated by sequential implantation of carbon and nitrogen ions correspondingly in N^+- and C^+-implanted samples of molybdenum. Experiments carried out in massive samples of monocrystaline molybdenum by X-ray analysis using a sliding beam have shown that formation of molybdenum nitrides is more preferable in comparison with occurrence of other possible phases (carbides and carbonitrides). 5 refs.; 2 figs.

47363 (INIS-SU–112, pp. 28-31) **Study of near-to-surface layers of α-Fe foil after Fe^{4+} ions irradiation and isochronous annealing.** Igrushin, V.V. (Khar'kovskij Gosudarstvennyj Univ., Kharkov (Ukrainian SSR)); Kirichenko, V.G.; Mashkarov, Yu.G.; Snurnikova, A.I.; Chekin, V.V.; Reznichenko, Eh.A. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Tsentral'nyj Nauchno-Issledovatel'skij Inst. Informatsii i Tekhniko-Ehkonomicheskikh Issledovanij po Atomnoj Nauke i Tekhnike. 1988. (In Russian). (BTs–23145). In *Physics of radiation damages and radiation material science. Scientific-technical collection.* Order Number DE89018004/JAW. Available from NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS.

Voprosy atomnoj nauki i tekhniki.; v. 5(47).

α-Fe foils deformed after Fe^{4+} ion implantation at room temperature and 500 deg C as well as after isochronous annealing in the range of 150-450 deg C (E=600 keV, PHI=$4x10^{16}$; $1x10^{17}$ and $1.4x10^{17}$ cm^{-2}, vacuum $1.3x10^{-2}$ Pa) are studied by the methods of Moessbauer spectroscopy, Reseuford backward scattering and X-ray analysis. About (+-)% of carbon is implanted in the near-to-surface layer of the sample together with iron ions introduction. Temperature dependences of Moessbauer spectrum lines spreading obtained according to the data on isochronous annealing have shown that fields of elastic stresses in the α-Fe matrix are caused by amorphous precipitations of carbide. 9 refs.; 1 fig.

47364 (INIS-SU–112, pp. 36-44) **Formation of strain martensite in 07Kh18N9 and 03Kh16N9M2 steels and radiation-induced structure-phase transformations.** Pecherin, A.M. (Nauchno-Issledovatel'skij Inst. Atomnykh Reaktorov, Dimitrovgrad (USSR)); Shamaridn, V.K.; Goncharenko, Yu.D.; Krasnoselov, V.A. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Tsentral'nyj Nauchno-Issledovatel'skij Inst. Informatsii i Tekhniko-Ehkonomicheskikh Issledovanij po Atomnoj Nauke i Tekhnike. 1988. (In Russian). (BTs–23145). In *Physics of radiation damages and radiation material science. Scientific-technical collection.* Order Number DE89018004/JAW. Available from NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS.

Voprosy atomnoj nauki i tekhniki.; v. 5(47).

Deformation of irradiated austenitic steels 07Kh18N9 and 03Kh16N9M2 in the temperature interval from 150 to 50 deg C is accompanied by (γ-α) martensite transformation. Intensity of martensite transformation is shown to be determined by radiation contitions. With the increase of radiation temperature intensity of (γ-α)-transformations during deformation is built up. Tendency to proceeding of this process is determined not only by radiation defects, but carbon atom segregation on dislocations and with further initial stage of carbideformation. 18 refs.; 4 figs.; 4 tabs.

47365 (INIS-SU–112, pp. 45-49) **Creep of bcc-alloys based on Fe under conditions of cyclic irradiation.** Bystrov, L.N. (AN SSSR, Moscow (USSR). Inst. Metallurgii); Tsepelov, A.B. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Tsentral'nyj Nauchno-Issledovatel'skij Inst. Informatsii i Tekhniko-Ehkonomicheskikh Issledovanij po Atomnoj Nauke i Tekhnike. 1988. (In Russian). (BTs–23145). In *Physics of radiation damages and radiation material science. Scientific-technical collection.* Order Number DE89018004/JAW. Available from NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS.

Voprosy atomnoj nauki i tekhniki.; v. 5(47).

Creep of α-Fe, Fe-15 weight % Cr and ferritic steel Fe-4%Cr-4%V-4%Al under conditions of cyclic electron irradiation (E=2 MeV) in the temperature range from 200 to 500 deg C is studied. Measurements of thermoactive parameters of creep (activation energy and activation volume) both under thermal and irradiation conditions are carried out. It is established that effect of radiation on bcc-materials investigated can be different depending on the structural state of the material and control creep mechanism realized in every concrete case. It is marked that in case of action of a slip mechanism of screw dislocations with steps irradiation leads to effective creep retardation. 7 refs.; 5 figs.

47366 (INIS-SU–112, pp. 50-53) **Temperature and amplitude dependence of internal friction in tantalum, niobium, dysprosium irradiated with electrons.** Zajkin, Yu.A. (Kazakhskij Gosudarstvennyj Univ., Alma-Ata (USSR)); Ivanov, M.S.; Gusar, O.L.; Kupchishin, A.I. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Tsentral'nyj Nauchno-Issledovatel'skij Inst. Informatsii i Tekhniko-Ehkonomicheskikh Issledovanij po Atomnoj Nauke i Tekhnike. 1988. (In Russian). (BTs–23145). In *Physics of radiation damages and radiation material science. Scientific-technical collection.* Order Number DE89018004/JAW. Available from NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS.

Voprosy atomnoj nauki i tekhniki.; v. 5(47).

Experimental amplitude dependences of internal friction in Ta, Nb, Dy measured in the wide range of the deformation amplitude before and after 1.8 MeV electron radiation up to the 10^{17} el/cm^2 dose are presented. The dependences obtained are shown to be presented as the sum of energy scattering processes, every of which is described by the string model. Analysis of radiation effect confirms the correctness of such interpretation. 5 refs.; 5 figs.

47367 (INIS-SU–112, pp. 54-57) **Effect of implantation on microhardness of niobium and molybdenum.** Diasamidze, Eh.M. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Sukhumi (USSR). Fiziko-Tekhnicheskij Inst.); Kalinin, A.N.; Kintsurashvili, M.Sh.; Nebieridze, Ts.M.; Sichinava, A.B. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Tsentral'nyj Nauchno-Issledovatel'skij Inst. Informatsii i Tekhniko-Ehkonomicheskikh Issledovanij po Atomnoj Nauke i Tekhnike. 1988. (In Russian). (BTs–23145). In *Physics of radiation damages and radiation material science. Scientific-technical collection.* Order Number DE89018004/JAW. Available from NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS.

Voprosy atomnoj nauki i tekhniki.; v. 5(47).

Dependence of microhardness on Wikkers extrusion depth of molybdenum and niobium alloyed with boron, nitrogen and argon ions with the 100 keV energy and doses $3x10^{15}$-$5x10^{18}$ cm^{-2} is investigated. Analysis is carried out on the assumption of the layer structure of the extruded material layer: ion-alloyed layer, applied modificated layer and the source material layer. Decrease of microhardness in the modified layer of ion-alloyed compositions: niobium-boron and molybdenum-nitrogen, is detected. 11 refs.; 2 figs.

47368 (INIS-SU–112, pp. 58-61) **Peculiarities of surface erosion of Kh13 steel during hydrogen plasma exposure.** Volkov, E.D. (AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst.); Gribanov, Yu.A.; Neklyudov, I.M.; Nikitin, A.V.; Opalev, O.A.; Rybalko, V.F.; Ternopol', A.M.; Chernyj, B.P.; Khazan, S.M. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Tsentral'nyj Nauchno-Issledovatel'skij Inst. Informatsii i Tekhniko-Ehkonomicheskikh Issledovanij po Atomnoj Nauke i Tekhnike. 1988. (In Russian). (BTs–23145). In *Physics of radiation damages and radiation material science. Scientific-technical collection.* Order Number DE89018004/JAW. Available from NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS.

Voprosy atomnoj nauki i tekhniki.; v. 5(47).

Surface erosion of ferritic-martensitic steel of the Kh13 type during hydrogen plasma ion radiation is studied. Coefficients of steel sputtering by hydrogen ions in the energy range from 0.6 to 1.2 keV is studied. Gas-filled voids are formed in the near-to-surface layer as a result of radiation by high doses of hydrogen ions. It is shown in the paper that the initial stage of such voids formation begins from doses $5x10^{18}$ ion/cm^2. With the increase of the dose formation of new voids in the surface depth occurs. Certain voids are in the depths of 400 μm from the surface. The depth of the occurrence of gas-filled voids from the surface irradiated exceeds hydrogen ion run more than 10^4 times.

47369 (INIS-SU–112, pp. 62-64) **Study of radiation damages of Ni monocrystals implanted with Xe^+ ions.** Tolstolutskaya, G.D. (AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst.); Rybalko, V.F.; Kopanets, I.E.; Neklyudov, I.M.; Gann, V.V. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Tsentral'nyj Nauchno-Issledovatel'skij Inst. Informatsii i Tekhniko-Ehkonomicheskikh Issledovanij po Atomnoj Nauke i Tekhnike. 1988. (In Russian). (BTs–23145). In *Physics of radiation damages and radiation material science. Scientific-technical collection.* Order Number DE89018004/JAW. Available from NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS.

Voprosy atomnoj nauki i tekhniki.; v. 5(47).

Xe atom position in the Ni monocrystal lattice implanted with Xe^+ ions with E=630 keV up to doses $1x10^{15}$-$5x10^{16}$ cm^{-2} is investigated by the method of backward scattering of He^+ channeling ions with energy 1.6 MeV. Dose dependence of distribution profiles of radiation defects formed in Ni under Xe^+ ion irradiation, and Xe position in the Ni lattice are studied. Good coincidence of defect distribution profiles measured experimentally with those calculated theoretically is shown. Position of Xe atoms implanted in the Ni lattice depends on the radiation dose changing from the substituting location (~ 40 %) at D $1x10^{15}$ cm^{-2} to choatic at D ~> $1x10^{16}$ cm^{-2}. 7 refs.; 2 figs.

47370 (LA-UR–89-2869) **The HEL [Hugoniot Elastic Limit] and rate-dependent yield behavior.** Follansbee, P.S. Los Alamos National Lab., NM (USA). [1989]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-890812–24: American Physical Society topical conference on shock compression of condensed matter, Albuquerque, NM (USA), 14-17 Aug 1989). Order Number DE89016981/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Measurements of the Hugoniot Elastic Limit are compared with measurements of the strain-rate dependent compressive yield stress in several metals. The measurements are analyzed according to standard thermal activation theory. In several cases, only data from material from a single lot are used in the comparison. Results in Ti-6Al-4V, W, Ta, and 1018 steel are presented. It is shown that in all of the materials investigated the HEL is below the mechanical threshold stress, or yield stress at 0K. Comparison of the HEL with compression measurements at low temperature and quasistatic strain rates and with compression measurements at room temperature and Hopkinson bar strain rates suggests that the strain rate associated with the HEL is on the order of 10^4 to 10^6 s^{-1}. 9 refs., 2 figs., 1 tab.

47371 (ORNL/FTR–2634) **[Alloy phase stability and intermetallic research]: Foreign trip report, June 12–July 11, 1987.** Liu, C.T. Oak Ridge National Lab., TN (USA). 3 Aug 1987. 23p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017398/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

I participated in the NATO Advanced Study Institute on "Alloy Phase Stability" sponsored by NATO, DOE and the Office of Naval Research (ONR). Three invited lectures on "Phase Stability and Alloy Design of Ordered Intermetallic Alloys" were given which summarized current effects on alloy design of ductile ordered intermetallics. The need of theoretical calculations to predict the structural stability in intermetallic phases was also stressed. Extensive discussions with participants on physical metallurgy and mechanical behavior of ordered intermetallics were held. After the NATO Advanced Study, I visited University of Neuchatel, Switzerland; Office of National d'Etudes et de Researches Aerospatiales (ONERA), France; Oxford University, England; and Imperial College, England. I gave a seminar on recent development of ordered intermetallics for high-temperature structural use at ONERA, the Institute of which is very active in both basic research and alloy development of Ni_3Al, Ti_3Al, and $TiAl_3$ aluminides for aerospace applications. Discussions and interactions with European scientists provided us with information useful to our current work on nickel and titanium aluminides and helpful for planning our future research on ordered intermetallics.

47372 (ORNL/FTR–2816) **[US-Japan workshop on small specimen test techniques, Tokyo, Japan, and visits to Sapporo, Fukuoka, and Nagoya, Japan, February 17–25, 1988]: Foreign trip report.** Zinkle, S.J. Oak Ridge National Lab., TN (USA). 7 Mar 1988. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017416/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler attended the US-Japan Workshop on Small Specimen Test Techniques. This workshop provided a forum to discuss recent advances in developing miniaturized specimens for mechanical property, fracture toughness, and corrosion measurements on irradiated materials. Following the workshop, the traveler visited four Japanese universities for detailed discussions on fundamental radiation effects research in metals and ceramics. A great deal of creativity was evident in the Japanese research program, and they have devised several novel irradiation experiments that allow fundamental defect survival parameters to be directly measured. Their findings support some recent results obtained in the US fusion materials program.

47373 (ORNL/FTR–2849) **[Program for measurements and models of grain boundary and surface energies of metals and ceramics]: Foreign trip report, March 7–17, 1988.** Carpenter, J.A. Jr.; Murr, L.E.; Schneibel, J.H.; Vitek, V.; White, C.L. Oak Ridge National Lab., TN (USA). 18 Apr 1988. 51p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. Order Number DE89017434/JAW. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

In a trip to India March 7–17, 1988, the five US travelers collaborated with researchers from three Indian institutions to develop a program for measurements to be made in India of grain boundary and surface energies of metals and ceramics. The Indian institutions were the Indian Institute of Technology of Kanpur, the Bhabha Atomic Research Center at Trombay, and the Indian Institute of Science in Bangalore. The primary purpose of the measurements is to provide a limited but crucial set of updated data for five selected materials systems using modern characterization equipment which data modelers can use to verify or calibrate various "Materials by Design" computer programs envisioned to someday be able to predict properties of "real world" materials or at least make more efficient their experimental development. Fairly extensive collaborations between Indian and American researchers are expected to take place. The five materials systems suggested for study are Ni, Cu, Ni_3Al, Type 316 stainless steel, and Al_2O_3 with various levels of dopants such as S, B, Sb, and Sn. These five systems were deemed attractive for study on the dual bases of being scientifically interesting while also being technologically important.

47374 (ORNL/Sub–85-27421/03) **Weldability of ductile nickel aluminides.** Maguire, M.C.; Edwards, G.R.; David, S.A. Oak Ridge National Lab., TN (USA); Colorado School of Mines, Golden, CO (USA). Center for Welding and Joining Research. May 1989. 185p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. (MT-CWR–089-033). Order Number DE89017452/JAW. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

A study was conducted to characterize hot ductility and heat-affected zone (HAZ) cracking behavior as a function of microstructure for a series of Ni_3Al-based alloys. Slip path length was influenced by grain size and antiphase domain (APD) structures. Grain size was varied by isothermal annealing, and APD structures were produced by oil quenching from temperatures above the ordering transition temperature. The ordering temperature was lowered by adding up to 8 at. pct chromium to a Ni_3Al+Hf+B alloy. Hot ductility and weldability correlated with grain size and antiphase domain (APD) size. Grain refinement and APD structures reduced slip path lengths and improved hot ductility. In general, hot ductility increased in high chromium alloys, and the highest ductility was observed in alloys with extensive APD structures. A model was developed to describe how a disordered skin at an antiphase domain boundary (APDB) influenced dislocation motion and reduced slip path length. HAZ cracking susceptibility was characterized by performing full penetration autogenous electron beam welds on 0.76 mm sheet. Welds with higher chromium content were less prone to HAZ cracking during welding, and slower welding speeds minimized cracking tendency in all alloys. 85 refs., 86 figs., 6 tabs.

47375 (PB–89-865323/XAB) **Epoxy coatings: Anticorrosive and antifouling. January 1980-May 1987 (Citations from World Surface Coatings Abstracts). Report for January 1980-May 1987.** National Technical Information Service, Springfield, VA (USA). Jul 1989. 153p. Available from NTISPC N01/MF N01.

This bibliography contains citations concerning the compositions and applications of anticorrosion and antifouling epoxy coatings. Applications include manufacturing equipment, marine structures and ships, reinforcing bars in concrete, sheet and construction steel, steel pipes, and tanks. Some of the citations report on effectiveness and durability of the coatings. Excluded are powder coatings and water-based coatings, which appear in other bibliographies. (This updated bibliography contains 400 citations, none of which are new entries to the previous edition.)

47376 (PB–89-865331/XAB) **Epoxy coatings: Anticorrosive and antifouling. June 1987-May 1989 (Citations from World Surface Coatings Abstracts). Report for June 1987-May 1989.** National Technical Information Service, Springfield, VA (USA). Jul 1989. 94p. Available from NTISPC N01/MF N01.

Supersedes PB–87-860649.

This bibliography contains citations concerning the compositions and applications of anticorrosion and antifouling epoxy coatings. Applications include manufacturing equipment, marine structures and ships, reinforcing bars in concrete, sheet and construction steel, steel pipes, and tanks. Some of the citations report on effectiveness and durability of the coatings. Excluded are powder coatings and water-based coatings, which appear in other bibliographies. (This updated bibliography contains 180 citations, all of which are new entries to the previous edition.)

47377 (Y/DX–833) **Electron beam welding: Model of high voltage bias transmission line and termination circuits.** Greer, J.T. Oak Ridge Y-12 Plant, TN (USA). Aug 1989. 15p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC05-84OS21400. Order Number DE89016900/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Three electron beam (EB) welding systems have experienced an excessive failure rate of the isolation transformer that supplies low voltage power to the high-deck control circuitry. The cost of this failure is $8K per transformer, plus installation, downtime expenses, etc. Nine transformers (twenty-two transformers since 1982) have been replaced in the last two years and represent a significant economic loss if this problem is not resolved. The commercial EB controller unit was purchased from Leybold-Heraeus Vacuum Systems, which has several other vendor-supplied parts. For example, the transmission line is a special build item and does not have published parameters. Off-line testing and model closure were required to attain these needed parameters. To obtain parameters for the transmission cable and to evaluate possible solutions, a model was constructed that predicts voltages and current for termination circuits and includes the four-conductor transmission cable used to bias and control the EB gun. To compound the problem, the entire high voltage deck is submerged in oil and limits the available space needed for termination circuits, etc. A low voltage test was performed that was used to attain good model closure and to provide critical cable parameters not previously available. The model was useful in assuring consistency for measured parameters and for estimating "hard to measure" parameters that were derived from test signals. Model closure was attained, and several possible termination circuits were evaluated. A termination for the transmission cable is proposed in this report. 6 figs.

47378 Alloy performance in coal gasification environments. Natesan, K. (Materials and Components Technology Div., Argonne National Lab., Argonne, IL (US)). pp. 264 of Materials for coal gasification. Sklizkov, G.V American Society for Metals, Metals Park, OH (1987). (CONF-871059–: Materials for coal gasification, Cincinnati, OH (USA), 10-15 Oct 1987).

Corrosion test data have been developed in simulated coal gasification atmospheres by using internally cooled ring specimens of several commercial structural alloys. The roles of our key variables (metal and gas temperatures, gas chemistry, and exposure time) in the oxidation-sulfidation degradation of alloys were examined. Metal recession data were obtained from the measurements of the scale thicknesses and depths of internal penetration; the results were used to assess the role(s) of several variables in the corrosion process and the impact on materials performance in the heat recovery units of coal gasification systems.

47379 Simulation of equilibrium segregation in alloys using the Embedded Atom method. Foiles, M. (Sandia National Labs., Livermore, CA (US)). vp of Computer-based microscopic description of the structure and properties of materials. Broughton, J.; Krakow, W.; Pantelides, S.T. Materials Research Society, Pittsburgh, PA (1986). (CONF-851217–: Materials Research Society meeting, Boston, MA (USA), 2-7 Dec 1985).

The Embedded Atom Method (EAM) is combined with Monte Carlo simulation techniques to determine the equilibrium segregation at internal defects and surfaces. This approach has been applied in the Ni Cu alloy system to the calculation of the surface composition profiles and the segregation at an edge dislocation. The surface composition profile of these alloys as a function of distance from the surface is found to vary non-monotonically with the top atomic layer strongly enriched in Cu and the near surface atomic layers enriched in Ni. The compositional variation in the core region of an edge dislocation shows enrichment of Ni in the compressed regions of the partial dislocation core and Cu enrichment in the expanded regions. In addition, the composition changes abruptly at the slip plane of the dislocation.

47380 Materials by design. Eberhardt, J. (U.S. Dept. of Energy, Energy Conversion and Utilization Technologies (ECUT), Washington, DC (US)); Hay, P.J.; Carpenter, J.A. Jr. vp of Computer-based microscopic description of the structure and properties of materials. Broughton, J.; Krakow, W.; Pantelides, S.T. Materials Research Society, Pittsburgh, PA (1986). (CONF-851217–: Materials Research Society meeting, Boston, MA (USA), 2-7 Dec 1985).

Major developments in materials characterization instrumentation over the past decade have helped significantly to elucidate complex processes and phenomena connected with the microstructure of materials and interfacial interactions. Equally remarkable advances in theoretical models and computer technology also have been taking place during this period. These latter now permit, for example, in selected cases the computation of material structures and bonding and the prediction of some material properties. Two assessments of the state of the art of instrumental techniques and theoretical methods for the study of material structures and properties have recently been conducted. This paper discusses aspects from these assessments of computational theoretical methods apply to materials.

47381 The effect of hydrogen on the deformation and fracture of PWA 1480. Walston, W.S.; Williams, J.C.; Moody, N.R.; Dollar, M.; Bernstein, I.M. pp. 896 of Superalloys 1988; Proceedings of the Sixth International Symposium, Champion, PA, Sept. 18-22, 1988. Duhl, D.N.; Maurer, G.; Antolovich, S.; Lund, C.; Reichman, S. Metallurgical Society, Inc., Warrendale, PA (US) (1988). (CONF-8809399–: 6. international symposium on superalloys, Champion, PA (USA), 18-22 Sep 1988).

The effect of internal hydrogen on mechanical properties and fracture behavior is studied in the single-crystal nickel-base superalloy PWA 1480. In particular, plane strain fracture toughness and tensile tests have been performed in hydrogen-free samples and hydrogen-gas phase-charged samples in two different sample orientations. The mechanical properties, as well as the fracture process, were found to be very dependent on orientation. Hydrogen did not affect the yield strength but reduced the uniform tensile elongation more than 75 percent. However, hydrogen reduced the tensile reduction-in-area and the fracture toughness by only 10 percent. Cleavage of the eutectic gamma-prime, as well as the role of hydrogen trapping, will be discussed. These results will be analyzed in terms of the effects that orientation, microstructure, and hydrogen have on the fracture process. 14 refs.

47382 Thermocapillary flow in a pulsed-laser weld pool. Russo, A.J. (Sandia National Labs., Albuquerque, NM (US)); Akau, R.L.; Jellison, J.L. vp of Heat transfer. Kim, J.H.; Ro, S.T.; Lee T.S. Hemisphere Publishing, New York, NY (1988). (CONF-8610118–: Korea/US joint heat transfer seminar on thermal engineering and high technology systems, Seoul (Republic of Korea), 16-22 Oct 1986).

Pulsed-laser welding produces short-lived weld pools which have strong radial temperature gradients at the pool surface. These gradients produce surface tension variations which usually reinforce the weak natural convective flows caused by radial temperature gradients. The flow in the molten pool is of interest because it can change the temperature distribution in and around the molten zone which can alter the weld shape, and because it controls the transport of surface contaminants (or alloying or doping materials in case of surface processing) into the substrate. A two-dimensional finite difference computer code is being developed to model the transient flow in a prescribed axisymmetric weld pool geometry. Flow fields have been calculated for high and low Prandtl number metals such as steel and aluminum. Some experimental results are presented which support the computational model.

47383 New interpretation of rupture strength using the potential drop technique. Vasatis, I. pp. 896 of Superalloys 1988; Proceedings of the Sixth International Symposium, Champion, PA, Sept. 18-22, 1988. Duhl, D.N.; Maurer, G.; Antolovich, S.; Lund, C.; Reichman, S. Metallurgical Society, Inc., Warrendale, PA (US) (1988). (CONF-8809399–: 6. international symposium on superalloys, Champion, PA (USA), 18-22 Sep 1988).

The effects of zirconium and carbon on the rupture behavior of an experimental blade alloy were examined and analyzed by using the notched rupture test and the dc potential drop technique. Differences in the rupture behavior, not detectable by simply comparing rupture times, revealed by using the experimental technique described in this paper, provided more in depth understanding of the material's behavior and useful guidance to the alloy developer. The results of this work clearly demonstrate that minor chemistry modifications in nickel base alloys do not necessarily affect the resistance to crack initiation and crack propagation in a similar manner. 19 refs.

47384 Rutherford-backscattering study of high-temperature oxidation of Y-implanted Fe-24Cr. King, W.E. (Argonne National Lab., IL (USA)); Grabowski, K.S.; Mitchell, D.F.; Baldo, P.M. *Oxidation of Metals (USA),* 31(3-4): 181-207 (Apr 1989). DOE Contract W-31-109-ENG-38.

The authors have investigated the effect of Y ion implantation on the high-temperature oxidation of Fe-24Cr using Rutherford-backscattering spectroscopy, secondary ion mass spectroscopy, and analytical electron microscopy. Results indicate that implantation of Y has a very large effect on the growth rate of the oxide compared to metals alloyed with Y. Analytical tools have been applied to determine the spatial distribution of Y, the microstructure of the oxide, and contribution of oxygen transport to the oxidation process. Results are compared with those of recent cation-diffusion measurements in Cr_2O_3 and Cr_2O_3 doped with Y_2O_3.

47385 Breakdown of chromium oxide scales in sulfur-containing environments at elevated temperatures. Baxter, D.J. (Argonne National Lab., IL (USA)); Natesan, K. *Oxidation of Metals (USA),* 31(3-4): 305-323 (Apr 1989). DOE Contract W-31-109-ENG-38.

Structural Fe-Cr-Ni alloys may be rapidly degraded in oxygen-sulfur mixed-gas environments at elevated temperatures unless protective oxide scales can be formed and maintained. The breakaway corrosion process was examined in model alloys of Fe-25 wt.% Cr-20 wt.% Ni with and without Nb and Zr additions. Oxide scales were preformed in S-free environments and subsequently exposed to oxygen-sulfur mixed-gas atmospheres. Preformed scales were found to delay the onset of breakaway corrosion. The beneficial effects of refractory metal additions were achieved via formation of a barrier layer at the Cr_2O_3-alloy interface.

3602 Ceramics, Cermets, and Refractories

Refer also to citation(s) 46816, 46824, 47329, 47339, 47347, 47372, 47373, 47377, 47384, 47385, 47408, 47713, 47725, 47761, 47847, 48533, 48535

47386 (AD-A–205953/3/XAB) **Fundamental and applied studies of explosively fabricated high-temperature superconducting fixtures. Quarterly technical report, 1 September-31 November 1988.** Murr, L.E. Oregon Graduate Center, Beaverton, OR (USA). Dept. of Materials Science and Engineering. Nov 1988. 39p. Available from NTIS, PC A03/MF A01.

The authors have explosively fabricated a wide variety of monolithic superconductor metal matrix fixtures in a variety of tooling-plate geometries, including a design which allowed the channels to be evacuated prior to and during the fabrication process. Tooling plates and fabricated monoliths were utilized in both silver and copper. Channel schedules included pure high quality $YBa_2Cu_3O_7$ superconducting powder having a size distribution of roughly 0.2 to 20 micrometers, and mixtures of superconducting (SC) powder with metal powders: 10%, 20%, and 30% silver powder primarily in the silver tooling plate, and the same volume fractions of metal powder loading in copper tooling plates. It was demonstrated that tape and ribbon could be easily cold rolled in a multiple pass rolling process from explosively-fabricated linear, monolithic precursors by as much as 95% (to a tape thickness of 0.15 mm). The silver tapes have the convenience of allowing for an annealing treatment or treatment series which can connect the superconducting tape core for supercurrent transport.

47387 (AD-A–207020/9/XAB) **Preparation and properties of La(2-x)AxCuO(4-y) where A = Pb,Cd. Technical report.** Niu, C.M.; Kim, C.H.; Kershaw, R.; Dwight, K.; Wold, A. Brown Univ., Providence, RI (USA). Dept. of Chemistry. 15 Apr 1989. 14p. (TR–19). Available from NTIS, PC A03/MF A01.

The substitution of lead and cadmium for lanthanum in La_2CuO_4 was studied and the limits of solubility were established. Single-phase compositions were characterized and their physical properties were correlated with the substitution of bismuth and are interpreted on the basis of a model proposed by Goodenough.

47388 (ANL/FE–89/5) **Transport properties of thermally grown Cr_2O_3.** Park, J.H.; Natesan, K. Argonne National Lab., IL (USA). May 1989. 33p. Sponsored by U.S. DOE Fossil Energy. DOE Contract W-31109-ENG-38. Order Number DE89016703/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The electrical conductivity of thermally grown chromium oxide (Cr_2O_3) has been measured as a function of temperature and over a range of oxygen partial pressures from that of air to that of the Cr/Cr_2O_3 equilibrium. The conductivity showed p-type behavior over the range of conditions of the present investigation. At temperatures above 1000°C, the conductivity values were independent of oxygen partial pressure and indicated intrinsic semiconductor behavior. The mobility of holes, determined by measuring conductivity at fixed compositions increased with temperature. The oxidation kinetics of Cr were determined by measuring the electrical conductivity and electromotive force across the oxide layer at 875°C. The result agreed well with the oxidation data obtained in thermogravimetric tests. The diffusivities of oxygen and sulfur in thermally grown chromium oxide were determined by means of electrical conductivity measurements. The measured diffusivity of sulfur in chromium oxide is at least one to two orders of magnitude higher than that of oxygen. The solubility of sulfur was also determined from the conductivity measurements. The solubility of sulfur decreased with an increase in temperature, but was almost constant below 800°C. 27 refs., 23 figs., 2 tabs.

47389 (IC–89/79) **Silicate bonded ceramics of laterites.** Wagh, A.S.; Douse, V. International Centre for Theoretical Physics, Trieste (Italy). May 1989. 41p. Order Number DE90601252/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Sodium silicate is vacuum impregnated in bauxite waste (red mud) at room temperature to develop ceramics of mechanical properties comparable to the sintered ceramics. For a concentration up to 10% the fracture toughness increases from 0.12 $MNm^{-3}2$/to 0.9 $MNm^{-3}2$/, and the compressive strength from 7 MNm^{-2} to 30 MNm^{-2}. The mechanical properties do not deteriorate, when soaked in water for an entire week. The viscosity and the concentration of the silicate solution are crucial, both for the success of the fabrication and the economics of the process. Similar successful results have been obtained for bauxite and lime stone, even though the latter has poor weathering properties. With scanning electron microscopy and energy dispersive analysis, an attempt is made to identify the crystals formed in the composite, which are responsible for the strength. The process is an economic alternative to the sintered ceramics in the construction industry in the tropical countries, rich in lateritic soils and poor in energy. Also the process has all the potential for further development in arid regions abundant in limestone. (author). 6 refs, 20 figs, 3 tabs.

47390 (INIS-mf–11515, pp. 73) **Complex susceptibility and magnetic properties of (Bi,Pb)SrCaCuO.** Jodlbauer, H. (Vienna Univ. (Austria). Inst. fuer Festkoerperphysik); Lang, W.; Markowitsch, W.; Schaffarich, P.; Kuzmany, H. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47391 (INIS-mf–11515, pp. 73) **Hall effect in ceramic high-temperature superconductors.** Lang, W. (Vienna Univ. (Austria). Inst. fuer Festkoerperphysik); Jodlbauer, H. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47392 (INIS-mf–11515, pp. 136) **Status of high-temperature superconductors research in Austria.** Schwarz, K. (Techn. Univ. Vienna, Inst. fuer Theoretische Festkoerperchemie, Vienna (Austria)). Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47393 (INIS-SU–112, pp. 32-35) **Effect of high temperature annealings on swelling and helium release in boron carbide irradiated with neutrons.** Bykov, V.N. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR. Obninsk (USSR). Fiziko-Ehnergeticheskij Inst.); Rudenko, V.A.; Tarasikov, V.P.; Shcherbak, V.I. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Tsentral'nyj Nauchno-Issledovatel'skij Inst. Informatsii i Tekhniko-Ehkonomicheskikh Issledovanij po Atomnoj Nauke i Tekhnike. 1988. (In Russian). (BTs–23145). In *Physics of radiation damages and radiation material science. Scientific-technical collection.* Order Number DE89018004/JAW. Available from NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS.

Voprosy atomnoj nauki i tekhniki.; v. 5(47).

The investigation results of helium content, measurement of limar sizes and boron carbide microstructure after irradiation at 350 deg C up to burnup of 1.4 and 2.6 % of boron and annealings in the temperature range from 1000 to 1400 deg C are presented in the paper. High-temperature annealing of boron carbide samples is shown to lead to considerable volume changes caused by porosity development both on boundaries and in a grain body, as well as to helium yield. The changes depended greatly on the temperature and grew with the increase of boron burnup. Effect of grain boundaries on void generation and growth near and on the grain boundaries themselves is considered; estimations of helium diffusion coefficient are carried out; dependence of the coefficient on annealing conditions and on characteristics of helium bubbles formed during annealing is shown. 7 refs.; 3 figs.; 1 tab.

47394 (INIS-SU–113/A, pp. 10-12) **Optical properties of superconducting metal oxide ceramics.** Golovashkin, A.I.; Zhurkin, A.B.; Krajskaya, K.V.; Shelekhov, A.L. AN SSSR, Moscow (USSR). Fizicheskij Inst. 1989. (In Russian). (T–23539). In *Experimental and theoretical physics. Collection.* Order Number DE89018003/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Kratkie soobshcheniya po fizike.; v. 1.

In the spectral range of 1-4 eV dispersion dependence of refractive index $R(\omega)$ of $YBa_2Cu_3O_{7-\delta}$, $Y_{1.8}Ba_{0.2}CuO_{4-y}$, $La_{1.83}Ba_{0.17}CuO_4$ ceramics is measured. With the temperature decrease from 300 to 77 K a nearly twofold decrease in the obsolute valus of refractive index and a change of $R(\omega)$ spectrum structure are detected. It is shown that with the temperature decrease a change in electronic structure takes place, which can be related to the change in the concentration and character of oxygen distribution in the crystals. 5 refs.; 3 figs.; 1 tab.

47395 (N–89-19421) **Improved silicon nitride for advanced heat engines. Annual contractor report.** Yeh, H.C.; Fang, H.T. AiResearch Casting Co., Torrance, CA (USA). Feb 1987. 113p. (NASA-CR–179525;NAS–1.26:179525;AIRESEARCH–86-60365). Available from NTIS, PC A06/MF A01.

The technology base required to fabricate silicon nitride components with the strength, reliability, and reproducibility necessary for actual heat engine applications is presented. Task 2 was set up to develop test bars with high Weibull slope and greater high temperature strength, and to conduct an initial net shape component fabrication evaluation. Screening experiments were performed in Task 7 on advanced materials and processing for input to Task 2. The technical efforts performed in the second year of a 5-yr program are covered. The first iteration of Task 2 was completed as planned. Two half-replicated, fractional factorial (2 sup 5), statistically designed matrix experiments were conducted. These experiments have identified Denka 9FW Si3N4 as an alternate raw material to GTE SN502 Si3N4 for subsequent process evaluation. A detailed statistical analysis was conducted to correlate processing conditions with as-processed test bar properties. One processing condition produced a material with a 97 ksi average room temperature MOR (100 percent of goal) with 13.2 Weibull slope (83 percent of goal): another condition produced 86 ksi (6 percent over baseline) room temperature strength with a Weibull slope of 20 (125 percent of goal).

47396 (N–89-20252) **Crystallization kinetics of $BaO-Al_2O_3-SiO_2$ glasses.** Bansal, N.P.; Hyatt, M.J. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. May 1988. 22p. (NASA-TM–101964;E–4662;NAS–1.15:101964;CONF-880504–: 90. annual meeting of American Ceramic Society, Cincinnati, OH (USA), 1-5 May 1988). Available from NTIS, PC A03/MF A01.

Barium aluminosilicate glasses are being investigated as matrix materials in high-temperature ceramic composites for structural applications. Kinetics of crystallization of two refractory glass compositions in the barium aluminosilicate system were studied by differential thermal analysis (DTA), X-ray diffraction (XRD), and scanning electron microscopy (SEM). From variable heating rate DTA, the crystallization activation energies for glass compositions (wt percent) ^{10}BaO-$^{38}Al_2O_3$-51SiO_2-1MoO_3 (glass A) and ^{39}BaO-$^{25}Al_2O_3$-$^{35}SiO_2$-1MoO_3 (glass B) were determined to be 553 and 558 kJ/mol, respectively. On thermal treatment, the crystalline phases in glasses A and B were identified as mullite ($^3Al_2O_3$-$^2SiO_2$) and hexacelsian (BaO-Al_2O_3-$^2SiO_2$), respectively. Hexacelsian is a high-temperature polymorph which is metastable below 1590 C. It undergoes structural transformation into the orthorhombic form at approximately 300 C accompanied by a large volume change which is undesirable for structural applications. A process needs to be developed where stable monoclinic celsian, rather than hexacelsian, precipitates out as the crystal phase in glass B.

47397 (N–89-21046) **Static tensile and tensile creep testing of five ceramic fibers at elevated temperatures.** Zimmerman, R.S.; Adams, D.F. Wyoming Univ., Laramie, WY (USA). Apr 1989. 130p. (NASA-CR–177525;NAS–1.26:177525). Available from NTIS, PC A07/MF A01.

Static tensile and tensile creep testing of five ceramic fibers at elevated temperature was performed. J.P. Stevens, Co., Astroquartz 9288 glass fiber; Nippon Carbon, Ltd., (Dow Corning) nicalon NLM-102 silicon carbide fiber; and 3M Company Nextel 312, 380, and 480 alumina/silica/boria fibers were supplied in unsized tows. Single fibers were separated from the tows and tested in static tension and tensile creep. Elevated test temperatures ranged from 400 C to 1300 C and varied for each fiber. Room temperature static tension was also performed. Computer software was written to reduce all single fiber test data into engineering constants using ASTM Standard Test Method D3379-75 as a reference. A high temperature furnace was designed and built to perform the single fiber elevated temperature testing up to 1300 C. A computerized single fiber creep apparatus was designed and constructed to perform four fiber creep tests simultaneously at temperatures up to 1300 C. Computer software was written to acquire and reduce all creep data.

47398 (ORNL/FTR–2844) **[Technologies for future industries]: Foreign trip report, March 18–31, 1988.** Becher, P.F. Oak Ridge National Lab., TN (USA). 15 Apr 1988. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017304/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The international symposium and various other technical meetings and visits afforded the traveler the opportunity to gain insight into recent advances in Japan on the development of high strength ceramics as well as toughened ceramics utilizing particulate, fiber, and whisker reinforcement. Discussions were also held with various researchers with interest in whisker reinforced ceramics and those interested in supplying whiskers for ORNL studies. It is noted that

the Japanese researchers and engineers have considerable interest in the development of whisker reinforced ceramics for a wide variety of applications.

47399 (ORNL/FTR–2859) **[Structure-property relationships in surface-modified ceramics]: Foreign trip report, April 11–24, 1988.** McHargue, C.J. Oak Ridge National Lab., TN (USA). 6 May 1988. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017285/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler attended a meeting of the directors of NATO-ASI entitled "Structure-Property Relationships in Surface-Modified Ceramics" that will be held in Italy in August 1988 for the purpose of defining the program and other organizational details. The visit to the University of Claude Bernard was to analyze data obtained there, at ORNL, and at GANIL in a collaborative research program, to exchange samples, and to plan further work. A new collaboration was initiated at Salford University that involves using their low energy ion implanter to lay surface-active species at the interface between metal films and ceramic substrates. The traveler and Prof. Page analyzed data obtained at ORNL and Newcastle in their ongoing collaborative research.

47400 (ORNL/FTR–3286) **[Current research in advanced materials]: Foreign trip report, May 29–June 3, 1989.** Craig, D.F. Oak Ridge National Lab., TN (USA). 19 Jun 1989. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017466/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The International Conference on Evolution of Advanced Materials addressed current research in the areas of design, processing, ferrous and nonferrous alloys, ceramics, glasses, composites, and powder metallurgy materials. Technical papers were presented by researchers from 16 countries. The traveler presented an invited lecture on structural ceramics in the advanced materials world.

47401 (ORNL/Sub–87-00184/01) **Low temperature processing of reaction sintered silicon nitride.** Starr, T.L.; Harris, J.N.; Mohr, D.L. Georgia Inst. of Tech., Atlanta, GA (USA). Research Inst. Jul 1989. 31p. Sponsored by U.S. DOE Fossil Energy. DOE Contract AC05-84OR21400. Order Number DE89017455/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The reaction sintering process offers significant advantages for fabrication of silicon nitride matrix composites. It is a near-net-shape process, making it suitable for large and complex bodies, and its lower processing temperature, as compared to hot-pressing or sintering, is more conducive to fiber stability. Successful composites with silicon carbide reinforcement have used either randomly dispersed whiskers or oriented monofilaments. Complete nitridation of conventional silicon powders requires a long period (several days) at temperatures approaching the melting point of silicon (1410°C). Some results with ultrafine silicon powder indicate full conversion in a short time at dramatically lower temperatures. This report describes our efforts to develop an improved silicon powder for nitriding and optimized processing for this material. 7 refs., 15 figs., 3 tabs.

47402 (PB–89-160618/XAB) **Specific heat in mono-crystal YbCo: lambda-like anomalies at 90 and 229K.** Fossheim, K.; Nes, O.M.; Laegreid, T. Selskapet for Industriell og Teknisk Forskning, Trondheim (Norway). 15 Sep 1988. 9p. (STF–19-A88009). Available from NTIS, PC EE03/MF E03.

The specific heat was measured with high precision in a monocrystal of $YBa_2Cu_3O_7$-delta (YBCO) superconductor in the temperature range 60-300K. The measurements provide data with a relative resolution delta C/C of approximately 5.10^4. The main conclusions are: (1) near the superconducting transition the specific heat shows influence of fluctuations; and (2) a reversible second-order or weakly first-order phase transition is found to occur at 229K.

47403 (PB–89-194088/XAB) **Study of the corrosion of ceramic materials in a simulated advanced glass melter flue-gas environment. Topical report, June 1987-May 1988.** Butt, D.P.; Mecholsky, J.J. Pennsylvania State Univ., University Park, PA (USA). Center for Advanced Materials. Oct 1988. 144p. (CAM–8806). Available from NTIS, PC A07/MF A01.

The report summarizes the mechanical response of two baseline silicon carbide materials and several other ceramic materials to a simulated advanced glass melter (AGM) flue-gas environment. The simulated environment consisted of sodium silicate injected into a heated gas stream. The two baseline silicon carbide materials consisted of a reaction-bonded siliconized silicon carbide with a bimodal grain-size distribution (2 to 5 micrometers and 25 to 75 micrometers) and a sintered alpha silicon carbide with a uniform average grain size of 2 to 5 micrometers. The other ceramic materials included several grades of alumina, silicon carbide/alumina composites, and alumina/alumina composites. In general, the strength and load-bearing capacity of the silicon carbide materials was degraded when subjected to temperatures above 960 C (1760 F). The alumina materials were little affected by the environment for times up to 240 hours and temperatures up to 1000 C (1832 F). The composite materials produced an alumina layer that appeared to protect the surface.

47404 (SAND–89-1115C) **Effects of shock-modification on superconductivity in $Tl_2Ca_2Ba_2Cu_3O_y$ and $Bi_2CaSr_2Cu_2O_x$.** Venturini, E.L.; Graham, R.A.; Ginley, D.S.; Morosin, B. Sandia National Labs., Albuquerque, NM (USA). 1989. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. (CONF-890812–28: American Physical Society topical conference on shock compression of condensed matter, Albuquerque, NM (USA), 14-17 Aug 1989). Order Number DE89017231/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Powder compacts of superconducting $Tl_2Ca_2Ba_2Cu_3O_y$ (Tl-2223) and $Bi_2CaSr_2Cu_2O_x$ (Bi- 2122) were subjected to controlled, quantitative high-pressure shock-wave loading in gas-tight copper recovery capsules and preserved for post-shock analysis. Magnetization data show a substantial decrease in both diamagnetic shielding and Meissner effect for both compounds following shock modification over a range of peak pressures from 7.5 to 27 GPa and peak temperatures from 150 to 850°C. There is a 5 K increase in the onset of superconductivity in shock-modified Tl-2223, while Bi-2122 shows no measurable change. Magnetic flux creep measurements at low temperature reveal a three-fold increase in the flux pinning energy for Tl-2223 following shock modification. 19 refs., 2 figs.

47405 (UCRL–100094) **Preparation and characterization of single phase $Ba_{1-x}K_xBiO_3$.** Folkerts, T.J.; Shelton, R.N.; Radousky, H.B. Lawrence Livermore National Lab., CA (USA). Jul 1989. 3p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890718–28: International conference on materials and mechanisms of superconductivity - high-temperature superconductors, Stanford, CA (USA), 23-28 Jul 1989). Order Number DE89017735/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

High quality single phase samples of $Ba_{1-x}K_xBiO_3$ (BKBO) have been made across the range of compositions from $0 < x < 0.5$. Powder x-ray diffraction data indicates pure single phase materials for all potassium concentrations. Samples with $x < 0.35$ are nonsuperconducting while those with $x > 0.35$ show sharp superconducting transitions from both resistivity and magnetization measurements. Care during sample preparation is vital for obtaining quality samples of this material. 4 refs., 3 figs.

47406 Electrical, optical and structural properties of thin SiO_2 films on Si. Ravindra, N.M. (Dept. of Physics, New Jersey Institute of Technology, Newark, NJ (US)); Russo, O.L.; Fathy, D.; Narayan, J.; Heyd, A.R.; Vedam, K. vp of SiO_2 and its interfaces. Pantelides S.T.; Lucovsky, G. Materials Research Society, Pittsburgh, PA (1988). (CONF-8711228–: SiO_2 and its interfaces symposium, Boston, MA (USA), 30 Nov - 5 dec 1987).

Breakdown voltage, static current-voltage, spectroscopic ellipsometry (SE), electrolyte electroreflectance (EER) and high resolution transmission electron microscopic (HRTEM) studies of thermally grown thin films of SiO_2 on silicon (800°C - dry) are reported here. The investigation of the electrical properties of these films lead up to suggest the criteria for determining the breakdown voltage of these 20 nm thick SiO_2 films. The Fowler-Nordheim tunneling contribution to current conduction mechanisms in SiO_2 has been considered in evaluating these criteria. SE, EER and HRTEM studies have been performed on SiO_2 films of thicknesses in the range of 1-20 nm. These studies lead us to determine the thickness of the

non-stoichiometric silicon-rich oxide existing at the Si-SiO_2 interface. EER studies show that the relative surface state densities for different film thicknesses can be determined. The role of the transition region in determining the dielectric strength of thin SiO_2 films is discussed.

47407 Nickel oxide, ceramic-insulated, high-temperature coating. Aprigiano, L.F. To Department of the Navy, Washington, DC. USA Patent 6-801,895. 26 Nov 1985. 8p. Available from NTIS, PC A02/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

A three layer composite coating for gas-turbine-engine materials and other materials exposed to high temperatures, thermal cycling, and corrosive environments. The base layer is aluminide or an MCrAlY composite, whre M is a metal selected from the group consisting of nickel or cobalt, alone or in combination. The middle layer is a ceramic composite. The outer layer is composed of nickel oxide.

3606 Other Materials

Refer also to citation(s) 46816, 46933, 47032, 47033, 47041, 47096, 47332, 47335, 47338, 47345, 47351, 47375, 47376, 47377, 47400, 47403, 47406, 47407, 47460, 47480, 47725, 47762, 47849, 48279, 48495, 48518, 48526

47408 (AD-A-206061/4/XAB) **Ultrafine microstructure composites prepared by chemical vapor deposition. Annual report, January-December 1988.** Lackey, W.J.; Freeman, G.B.; Hanigofsky, J.A.; Thompson, J.R.; Gerard, G.J. Georgia Inst. of Tech., Atlanta, GA (USA). Research Inst. Dec 1988. 46p. (GTRI-A-4699-2). Available from NTIS, PC A03/MF A01.

The authors succeeded in preparing dispersed-phase composite coatings which consist of a boron nitride matrix containing aluminum nitride. Chemical vapor deposition (CVD) offers an alternate avenue of preparing ceramic composites by simultaneous deposition of multiple phases (i.e., codeposition). The major advantage of preparing dispersed-phase ceramic composites by CVD is that mechanical as well as chemical, electrical, optical, and thermal properties of the composites can be favorably tailored by controlling the composite composition and microstructure. Dispersed phase composites containing BN+ALN were deposited by CVD. The phases were either amorphous or crystalline depending on the deposition temperature and reagent concentration. One type of deposit which consisted of a turbostratic BN matrix containing oriented single crystal whiskers of ALN was very hard. A qualitative model based on statistical-mechanical nucleation theory and a hypothesized competition between growth of BN and ALN phases was successful in describing the relationship between operating conditions and the resulting microstructure of dispersed phase ceramic (BN+ALN) composites prepared by CVD. This study has provided a fundamental basis for developing more quantitative models, which will integrate the underlying principles of thermodynamics, kinetics, transport phenomena, nucleation and crystal growth theory.

47409 (AD-A-207197/5/XAB) **Two-photon absorption characterization. Interim performance report, 28 August-27 November 1988.** Littler, C.L.; Seiler, D.G. North Texas State Univ., Denton, TX (USA). Dept. of Physics. Jan 1989. 17p. Available from NTIS, PC A03/MF A01.

Magneto-optical measurements of Hg(1-X)Cd(X)Te alloys have provided a new means of studying impurities and defects in this important II-VI material. Two-photon magnetoabsorption (TMPA) was used to accurately determine the temperature dependence of the energy gap of various HgCdTe alloys, revealing behavior that deviates from currently accepted models. In addition, magneto-optical techniques were used to detect the presence of both shallow and deep impurities/defects and accurately determine their activation energies, thus providing information necessary for understanding the electrical and optical properties of the material.

47410 (AD-A-207198/3/XAB) **Two-photon absorption characterization of HgCdTe. Interim report (Annual), August 1987-August 1988.** Seiler, D.G. North Texas State Univ., Denton, TX (USA). Dept. of Physics. Jan 1989. 81p. Available from NTIS, PC A05/MF A01.

Magneto-optical measurements of Hg(1-x)Cd(x)Te alloys have provided a new means of studying impurities and defects in this important II-VI material. Two-photon magnetoabsorption (TMPA) was used to accurately determine the temperature dependence of the energy gap of various HgCdTe alloys, revealing behavior that deviates from currently accepted models. In addition, magneto-optical techniques were used to detect the presence of both shallow and deep impurities/defects and accurately determine their activation energies, thus providing information necessary for understanding the electrical and optical properties of the material.

47411 (AD-A-207220/5/XAB) **MeV implantation studies in LPE (liquid phase epitaxy)-grown GaAs and InP. Final report, 1 October 1987-31 March 1989.** Park, Y.S. State Univ. of New York, Buffalo, NY (USA). Dept. of Electrical Engineering. 31 Mar 1989. 80p. Available from NTIS, PC A05/MF A01.

Research was conducted on growth and evaluation of high-quality gallium arsenide layers using liquid phase epitaxy (LPE) and on MeV ion-implantation processings of molecular beam epitaxy (MBE) grown GaInAs layers on GaAs and LPE-grown GaAs layers on GaAs. By a novel growth method i.e., isoelectronic doping of LPE GaAs layers with indium, high structural and electrical-quality layers were successfully grown. In the as-grown indium-doped LPE GaAs layers, the etch-pit density, rocking-curve FWHM, and the ideality factor of a Schottky diode improved significantly, showing an optimal In doping density of 2.4×10^{19}. The effects of MeV-ion bombardment in a strained but partially relaxed GaInAs epitaxial layers on GaAs were systematically investigated. Depending on the state of initial relaxation, film thickness, and incident ion-beam current, the lattice strain changed differently with the increasing ion-beam dose.

47412 (AD-A-207271/8/XAB) **Compressive properties of high-performance polymeric fibers. Interim report, April-December 1988.** Fawaz, S.A.; Palazotto, A.N.; Wang, C.S. Dayton Univ., OH (USA). Research Inst. Mar 1989. 102p. Available from NTIS, PC A06/MF A01.

In directing the research effort for improving the compressive properties of rigid-rod polymeric composite fibers, a reliable testing technique for determining compressive properties is needed. The technique developed used the Tecam Micro-Tensile Testing Machine, MTM-8 and allowed direct tension and compression testing of composite fibers of extremely short gage length. The measured data were analyzed for corrections in machine compliance and possible errors in gage length misreading, fiber slippage, glue deformation, fiber misalignment, and nonuniform stress distribution. A nonpolymeric fiber was tested to determine if any fiber material dependence existed.

47413 (AD-A-207484/7/XAB) **Investigations of the quantum photovoltaic effect in InAs-GaSb semiconductor superlattices.** Bleuse, J.; Voisin, P.; Voos, M.; Munekata, H.; Chang, L.L. International Business Machines Corp., Yorktown Heights, NY (USA). Thomas J. Watson Research Center. 8 Feb 1988. 4p. Available from NTIS, PC A02/MF A01.

Pub. in Applied Physics Letters, Vol. 52, No. 6, 462-464(8 Feb 1988).

The authors report observation in InAs-GaSb semiconductor superlattices of a photovoltaic effect that has a quantum origin, as it arises from the spatial separation of the electron and hole ground-state wave functions in these type II superlattices. The results are consistent with the simplest theoretical predictions, except for the voltage sign, which evidence a depopulation of the surface layer.

47414 (BNL-43186) **Polyelectrolyte-diffused zinc phosphate conversion coatings and polyacid coupling primers for corrosion protection of steel and aluminum, and alkali-catalyzed hydrolysis of polyimide-based materials: Final report.** Sugama, T.; Kukacka, L.E.; Carciello, N.R.; Warren, J.B.; Clayton, C.R. Brookhaven National Lab., Upton, NY (USA). Aug 1989. 96p. Sponsored by U.S. Department of Defense. DOE Contract AC02-76CH00016. Order Number DE89017597/JAW. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

Under US Army Research Office (ARO) sponsorship, Brookhaven National Laboratory (BNL) performed research on three topics: (1)

polyelectrolyte-modified zinc phosphate (Zn·Ph) conversion coatings for the corrosion protection of steel, (2) water-soluble polyacid coupling primers for improving the corrosion resistance and adherence of polymeric paints, and (3) high-temperature lightweight polyimide material systems. In the first topic, it was found that insoluble crystalline zinc phosphate (Zn·Ph) conversion coatings can be produced on steel surfaces by immersing a surface-cleaned cold-rolled steel substrate into a BNL-developed phosphating solution containing three components, zinc orthophosphate dihydrate $[Zn_3(PO_4)_2 \cdot 2H_2O]$, H_3PO_4, and water. The major phase in the conversion coating derived from this simple phosphating solution is the same zinc phosphate dihydrate as that used in the converting solution. Referring to the second topic, it was found that the poly(itaconic acid), p(IA), which contains two functional COOH groups located on the same backbone carbon, has potential for use as a water-soluble intermediate coupling primer for polymer adhesive/Al_2O_3 adherend joint systems. Emphasis in the third topic was placed on understanding the reaction processes and degradation mechanisms of PI polymers which occur at the interfaces between the PI and inorganic pigments in hydrothermal environments at $\geq$150°C.

47415 (CONF-8409210–, pp. 63-100) **The materials of xerography: A case study in the interaction of engineering and science.** Duke, C.B. (Xerox Corp., Webster, NY (USA)). Oak Ridge National Lab., TN (USA); Texas A and M Univ., College Station, TX (USA). Dept. of Chemistry. 1984. From Texas A and M symposium on theory, modeling and instrumentation for materials design; College Station, TX (USA); 17-19 Sep 1984. In *Theory, modeling and instrumentation for materials by design. Proceedings of workshop.* Order Number DE89007940/JAW. Available from NTIS, PC A99/MF A01.

A series of slides is presented which were used to illustrate the author's workshop presentation. His presentation covered the following topics: the xerographic process: models of the process; models and materials specification; and polymers as xerographic materials. A nested set of system-subsystem-materials models were used to design xerographic copier/duplicator/printer devices. The unique role of these models in materials design are: specification of lumped-parameter performance; design of composite materials; functional characterization of consumables; and generation of coherent design approach to new materials options.

47416 (CONF-8409210–, pp. 243-272) **Multiconfigurational Green's function approaches in quantum chemistry.** Yeager, D.L. (Texas A and M Univ., College Station (USA)). Oak Ridge National Lab., TN (USA); Texas A and M Univ., College Station, TX (USA). Dept. of Chemistry. 1984. From Texas A and M symposium on theory, modeling and instrumentation for materials design; College Station, TX (USA); 17-19 Sep 1984. In *Theory, modeling and instrumentation for materials by design. Proceedings of workshop.* Order Number DE89007940/JAW. Available from NTIS, PC A99/MF A01.

The author discusses multiconfigurational Green's function techniques and generalizations. In particular he is interested in developing and applying these techniques for isolated atoms and small molecules. Furthermore, he develops formalisms that are fairly clear, accurate, and capable of being applied to open-shell and highly-correlated systems as well as to closed-shell systems with little electronic correlation. The two kinds of Green's functions that this article discusses are the single-particle Green's function and the retarded two-time Green's function in the energy representation. The poles of the former give the ionization potentials and electron affinities while the poles of the latter give the excitation energies. The multiconfigurational approximations are known as the multiconfigurational electron propagator (MCEP) and the multiconfigurational time-dependent Hartree-Fock (MCTDHF) (also known as the multiconfigurational random phase approximation (MCRPA) or the multiconfigurational linear response), respectively. 44 references.

47417 (CONF-8409210–, pp. 551-583) **Atomic scattering as a probe of physical adsorption.** Cole, M.W. (Pennsylvania State Univ., University Park (USA)). Oak Ridge National Lab., TN (USA); Texas A and M Univ., College Station, TX (USA). Dept. of Chemistry. 1984. From Texas A and M symposium on theory, modeling and instrumentation for materials design; College Station, TX (USA); 17-19 Sep 1984. In *Theory, modeling and instrumentation for materials by design. Proceedings of workshop.* Order Number DE89007940/JAW. Available from NTIS, PC A99/MF A01.

The paper discusses a close collaboration between theory and experiment, especially experimental data that allow one to have an extremely quantitative picture of the adsorption of noble gas atoms on surfaces - which is itself of great fundamental interest and is also useful as a probe of the surface per se. This discussion was largely devoid of ab initio calculation. The author described briefly about the helium-diamond and helium-krypton-graphite case. Those were truly ab initio, but most of the information in the physisorption regime about gas surface interactions is due to experiment, thermodynamic, neutron scattering, and especially the atomic scattering technique. In a few cases, one can determine things by ab initio calculation, but a semiempirical correlation has now been developed. That is, the idea of universal potential shapes can be used to predict properties of new systems that have never been explored before. If one wants to known something about the electronic configuration near the surface of a solid, scattering is the tool of choice for doing that and provides a very precise sort of information about that quantity.

47418 (CONF-8907138–1) **Computer simulations of two-dimensional quasiperiodic crystal and random tiling models.** Strandburg, K.J. Argonne National Lab., IL (USA). Aug 1989. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 4. Adriatico research conference (AARC '89) on quasicrystals; Trieste (Italy); 4-7 Jul 1989. Order Number DE89016909/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The recent discovery of quasicrystalline materials exhibiting resolution-limited diffraction peaks focusses attention on those quasicrystalline models which predict long-range translational order. Two such models have been suggested: the quasiperiodic crystal model (for which the Penrose tiling is the prototype) and the random tiling model (analogous to allowing arbitrary spacefilling arrangements of the Penrose rhombuses). Physically, the two models are distinguished by primary dependence on energy and entropy, respectively, in stabilizing the quasicrystal phase. Here we describe computer simulation results for simple two-dimensional realizations of each model. 24 refs., 13 figs.

47419 (DOE/ER/45140–T1) **Effect of thermal and cyclic loads on silicon carbide yarn reinforced glass matrix composites: Final report, August 15, 1984–February 14, 1988.** Avva, V.S.; Sankar, J. North Carolina Agricultural and Technical State Univ., Greensboro, NC (USA). 11 Aug 1989. 81p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-84ER45140. Order Number DE89016554/JAW. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This research investigated SiC fiber yarn in a borosilicate glass matrix. The following were objectives of the study: developing a suitable tabbing technique for room temperature and elevated temperature tensile testing of this new SiC yarn/glass composites; developing a procedure for specimen preparation after tabbing for proper alignment in test machine; tensile testing and development of S-N diagram at room temperature for this system; and scanning electron and optical microscopy study of fracture surfaces. 23 refs., 47 figs., 6 tabs.

47420 (DOE/ER/45274–3) **[Thermodynamics, kinetics, and interfare morphologies of phase formation reactions between metals and gallium arsenide: Bulk vs thin-film studies].** Chang, Y.A. Wisconsin Univ., Madison, WI (USA). [1989]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER45274. Order Number DE89016469/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

During the past two years or so, we have been carrying out the following studies: (i) investigation of the thermodynamic stabilities of selected GaAs/M couples by determining the Ga-M-As phase diagrams at one temperature in the composition region of importance to the metallization of GaAs and (ii) determination of the kinetics and morphologies of reactions between GaAs and M for both bulk and thin-film cases. The metallic elements which have been studied are Pd, Pt, Ir, Rh, Nb, Co and Ni. In the following, we will summarize briefly our accomplishments. 27 refs.

47421 (DOE/NASA/16310–10) **The interface in tungsten fiber reinforced niobium metal-matrix composites.** National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Sep 1989. 75p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AI03-86SF16310. (NASA-TM–102122). Order Number DE89017744/JAW. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The creep resistance of tungsten fiber reinforced niobium metal-matrix composites was evaluated. The interface region between the fiber and matrix was characterized by microhardness and electron probe microanalysis measurements which indicated that its properties were between those of fiber and matrix. However, the measured properties of the composite exceeded those calculated by the rule of mixtures even when the interface zone was assumed to retain all the strength of the fiber. The composite structure appeared to enhance the strengths of both the fibers and the matrix above what they exhibited in stand-alone tests. The effect of fiber orientation and matrix alloy composition on the fiber/matrix interface were also evaluated. Small alloying additions of zirconium and tungsten to the niobium matrix affected the creep resistance of the composites only slightly. A decrease in the creep resistance of the composite with increasing zirconium content in the matrix was ascribed to an increase in the diffusion rate of the fiber/matrix interdiffusion reaction, and a slight increase in the creep resistance of the composite was observed with an addition of 9 w % tungsten to the matrix. In addition. Kirkendall void formation was observed a the fiber/matrix interface; the void distribution differed depending on the fiber orientation relative to the stress axis. 36 refs., 26 figs., 6 tabs.

47422 (INIS-mf–11515, pp. 74) **Mass-spectrometric depth profile analysis of $YBa_2Cu_3O_x$ single crystals.** Eisl, M. (Technische Univ., Graz (Austria). Inst. fuer Festkoerperphysik); Schweiger, E.; Leising, G.; Leisch, M. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47423 (INIS-mf–11515, pp. 76) **High-temperature superconductors: physical properties of single crystalline- and polycrystalline samples, and of thin films.** Abt, R. (Technische Univ., Graz (Austria). Inst. fuer Festkoerperphysik); Aichholzer, K.; Kahlert, H.; Leising, G.; Leitner, O.; Pankl, C.; Pressl, K.; Roth, K.; Schweiger, E.; Wippel, V. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47424 (INIS-mf–11515, pp. 74) **Infrared reflection and magnetic susceptibility of $Ba_{1-x}K_xBiO_{3-\delta}$.** Markowitsch, W. (Vienna Univ. (Austria). Inst. fuer Festkoerperphysik); Jodlbauer, H.; Lang, W. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47425 (INIS-mf–11515, pp. 76) **Superconductivity and magnetic order in $Y_{1-x}Pr_xBa_2Cu_3O_7$.** Hilscher, G. (Technische Univ., Vienna (Austria). Inst. fuer Experimentalphysik); Pillmayr, N.; Felner, I. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47426 (INIS-mf–11515, pp. 75) **Influence of doping with Sb, Pb and Ag in the high-temperature superconductor systems Bi-Sr-Ca-Cu-O and Tl-Ba-Ca-Cu-O.** Gruber, H. (Technische Univ., Graz (Austria). Inst. fuer Festkoerperphysik); Krautz, E.; Fritzer, H.P.; Gatterer, K.; Sitte, W.; Popitsch, A. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47427 (INIS-mf–11515, pp. 75) **Far infrared spectroscopy on high temperature superconductors. $YBa_2Cu_{3-x}Zn_xO_{7-y}$.** Strasser, G. (Innsbruck Univ. (Austria). Inst. fuer Experimentalphysik); Vogl, G.; Seidenbusch, W.; Gornik, E. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47428 (INIS-mf–11515, pp. 64) **Electron spin resonance of radiation-induced defects in calcite.** Bettinger, D. (Johannes Kepler Univ., Linz (Austria). Inst. fuer Experimentalphysik); Jantsch, W.; Hille, P. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47429 (INIS-mf–11515, pp. 67) **Defects in H^+- and He^+-irradiated silicon.** Reisinger, J. (Johannes Kepler Univ., Linz (Austria). Inst. fuer Experimentalphysik); Palmetshofer, L. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47430 (LA-UR–89-2685) **Non-aqueous polypyrrole colloids: Synthesis and characterization.** Armes, S.P.; Aldissi, Mahmoud. Los Alamos National Lab., NM (USA). 1989. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-890978–1: 21. Europhysics conference on macromolecular physics: electrical and optical active polymers, Lodz (Poland), 4-8 Sep 1989). Order Number DE89016589/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The preparation of sterically-stabilized polypyrrole colloids via a dispersion polymerization route in non-aqueous media is described for the first time. Pyrrole polymerization was achieved using $FeCl_3$ as an oxidant/dopant in organic solvents such as methyl acetate, methyl formate and propyl formate. Macroscopic precipitation was prevented by the use of poly (vinyl acetate) as a polymeric surfactant. Other surfactants, used successfully in aqueous media, were incompatible and consequently resulted in precipitation of polypyrrole. Several techniques were used for characterization of the dispersions including transmission and scanning electron microscopies (TEM and SEM), thermogravimetric analysis (TGA), velocity charge analysis and visible absorption spectroscopy. TEM indicated a polydisperse spherical morphology with a particle diameter in the range 100-300 nm. The compressed pellet conductivity of the dried dispersion was 0.1 S/cm. These dispersions are often compared with aqueous bulk polypyrrole and aqueous dispersions. 11 refs., 3 figs., 1 tab.

47431 (LA-UR–89-2806) **3-D structures and intrinsic defects in trans-polyacetylene.** Vogl, P.; Campbell, D.K. Los Alamos National Lab., NM (USA). 1989. 7p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-8903160–1: Kirchberg workshop on electronic properties of polymers and related compounds, Boston, MA (USA), Mar 1989). Order Number DE89016972/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We report first-principles local-density functional pseudopotential calculations of static and dynamic electronic structure properties of

crystalline 3-D trans–$(CH)_x$. We find a broken symmetry ground state of $P2_1/a$ symmetry with in-phase dimerizations. Using a Green's function technique, we show that the 3-D character of the electronic band edge states strongly suppresses self-trapping, destabilizing polarons and possibly bipolarons as well in perfectly ordered 3-D trans–$(CH)_x$. 26 refs.

47432 (LA-UR–89-2840) **Chevron layer structures in surface stabilized ferroelectric liquid crystal (SSFLC) cells filled with a material which exhibits the chiral nematic to smetic C* phase transition.** Rieker, T.P.; Clark, N.A.; Safinya, C.R. Los Alamos National Lab., NM (USA). [1989]. 17p. Sponsored by National Science Foundation. DOE Contract W-7405-ENG-36. DMR8307157;CRR8622236;DAAL03-86-0053. (CONF-8906207–1: Symposium on ferroelectric liquid crystals, Goteborg (Sweden), 27-30 Jun 1989). Order Number DE89016985/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In this paper we report on the layer structure in Surface Stabilized Ferroelectric Liquid Crystal (SSFLC) electro-optic cells, adopted by a compound which exhibit the smectic C* (SC*) to chiral nematic (N*) phase transition. This class of compounds is unique in that the SC* layers form directly from the N* phase. These materials demonstrate a large tilt (Θ) of the director (n̂) from the layer normal (ẑ′) immediately upon cooling into the SC* phase. Recent high resolution x-ray experiments have demonstrated the presence of a chevron layer structure of tilted layers in compounds which exhibit the smectic A (SA) to SC* and the N*-SC* phase transitions, and also in a compound which has a very broad smectic A Phase. Chevron formation in smectic samples is a result of the layers anchoring normal or nearly normal to the bounding plates and subsequent layer contraction in the absence of dislocations. Patel and Goodby have demonstrated that compounds which exhibit the N*-SC* phase transition in the SSFLC geometry can be aligned by the application of an electric field across a cell with a buffed polymer surface treatment. With this method two domains of smectic layers form at large angles to the buffing direction normal. This is a consequence of the system simultaneously satisfying the imposed alignment direction, the large director tilt angle Θ, surface stabilization and the alignment of the polarization (P) along E. 9 refs., 5 figs.

47433 (LA-UR–89-2864) **Shock induced dissociation of polyethylene.** Morris, C.E.; Loughran, E.D.; Mortensen, G.F.; Gray, G.T. III; Shaw, M.S. Los Alamos National Lab., NM (USA). 1989. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-890812–29: American Physical Society topical conference on shock compression of condensed matter, Albuquerque, NM (USA), 14-17 Aug 1989). Order Number DE89016983/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

To identify the physical processes occurring on the Hugoniot, shock-recovery experiments were performed. Cylindrical recovery systems were used that enabled a wide range of single-shock Hugoniot states to be examined. Mass spectroscopy was used to examine the gaseous dissociation products. X-ray and TEM measurements were made to characterize the post-shock carbon structures. A dissociation product equation of state is presented to interpret the observed results. Polyethylene (PE) samples that were multiply shocked to their final states dissociated at much higher pressures than single-shocked samples. 5 refs., 2 figs., 1 tab.

47434 (N–89-19385) **Effects of simulated space environmental parameters on six commercially available composite materials.** Funk, J.G.; Sykes, G.F. Jr. National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center. Apr 1989. 34p. (NASA-TP–2906;L–16549;NAS–1.60:2906). Available from NTIS, PC A03/MF A01.

The effects of simulated space environmental parameters on microdamage induced by the environment in a series of commercially available graphite-fiber-reinforced composite materials were determined. Composites with both thermoset and thermoplastic resin systems were studied. Low-Earth-Orbit (LEO) exposures were simulated by thermal cycling; geosynchronous-orbit (GEO) exposures were simulated by electron irradiation plus thermal cycling. The thermal cycling temperature range was -250 F to either 200 F or 150 F. The upper limits of the thermal cycles were different to ensure that an individual composite material was not cycled above its glass transition temperature. Material response was characterized through assessment of the induced microcracking and its influence on mechanical property changes at both room temperature and -250 F. Microdamage was induced in both thermoset and thermoplastic advanced composite materials exposed to the simulated LEO environment. However, a 350 F cure single-phase toughened epoxy composite was not damaged during exposure to the LEO environment. The simuated GEO environment produced microdamage in all materials tested.

47435 (N–89-20205) **^{13}C NMR analysis of the effects of electron radiation on graphite/polyetherimide composites. Final report.** Ferguson, M.W. Norfolk State Coll., VA (USA). Mar 1989. 9p. (NASA-CR–182818;NAS–1.26:182818). Available from NTIS, PC A02/MF A01.

Initial investigations have been made into the use of high resolution nuclear magnetic resonance (NMR) for the characterization of radiation effects in graphite and Kevlar fibers, polymers, and the fiber/matrix interface in graphite/polyetherimide composites. Sample preparation techniques were refined. Essential equipment has been procured. A new NMR probe was constructed to increase the proton signal-to-noise ratio. Problem areas have been identified and plans developed to resolve them.

47436 (N–89-20206) **Finite element applications to explore the effects of partial bonding on metal matrix composite properties.** Caruso, J.J.; Trowbridge, D.; Chamis, C.C. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Apr 1989. 25p. (NASA-TM–101482;E–4610;NAS–1.15:101482;CONF-8904112–: 30. structures, structural dynamics and materials conference, Mobile, AL (USA), 3-5 Apr 1989). Available from NTIS, PC A03/MF A01.

The mechanics of materials approach (definition of E, G, Nu, and Alpha) and the finite element method are used to explore the effects of partial bonding and fiber fracture on the behavior of high temperature metal matrix composites. Composite ply properties are calculated for various degrees of disbonding to evaluate the sensitivity of these properties to the presence of fiber/matrix disbonding and fiber fracture. The mechanics of materials approach allows for the determination of the basic ply material properties needed for design/analysis of composites. The finite element method provides the necessary structural response (forces and displacements) for the mechanics of materials equations. Results show that disbonding of fractured fibers affect only E sub (111) and alpha sub (111) significantly.

47437 (N–89-20821) **Heavy Ion Induced single event phenomena (SEP) data for semiconductor devices from engineering testing.** Nichols, D.K.; Huebner, M.A.; Price, W.E.; Smith, L.S.; Coss, J.R. Jet Propulsion Lab., Pasadena, CA (USA). Jul 1988. 71p. (NASA-CR–184864;JPL-PUBL–88-17;NAS–1.26:184864). Available from NTIS, PC A04/MF A01.

The accumulation of JPL data on Single Event Phenomena (SEP), from 1979 to August 1986, is presented in full report format. It is expected that every two years a supplement report will be issued for the follow-on period. This data for 135 devices expands on the abbreviated test data presented as part of Refs. (1) and (3) by including figures of Single Event Upset (SEU) cross sections as a function of beam Linear Energy Transfer (LET) when available. It also includes some of the data complied in the JPL computer in RADATA and the SPACERAD data bank. This volume encompasses bipolar and MOS (CMOS and MHNOS) device data as two broad categories for both upsets (bit-flips) and latchup. It also includes comments on less well known phenomena, such as transient upsets and permanent damage modes.

47438 (N–89-21047) **Effect of geometry on thermal aging behavior of Celion/LARC-160 composites.** Nelson, J.B. National Aeronautics and Space Administration, Hampton, VA (USA). Langley Research Center. Dec 1987. 23p. (NASA-TM–100496;NAS–1.15:100496). Available from NTIS, PC A03/MF A01.

Laminates of Celion/LARC-160, fabricated in thicknesses from 4 to 16 ply and in unidirectional, x-ply and fabric ply configurations, were isothermally aged at temperatures of 204, 260 and 316 C for periods up to 15,000 hours. Weight-loss of the test panels was measured at selected intervals during aging. At the lower aging

temperatures, it was observed that panel thickness and ply arrangement influenced the apparent stability: i.e., thicker panels degraded less than thin panels and unidirectional panels degraded less than x-ply or fabric reinforced panels. At higher aging temperatures, all panel configurations and thicknesses converged toward the same behavior.

47439 (N–89-21104) **Simulation of the low earth orbital atomic oxygen interaction with materials by means of an oxygen ion beam.** Banks, B.A.; Rutledge, S.K.; Paulsen, P.E.; Steuber, T.J. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. 1989. 32p. (NASA-TM–101971;E–4671;NAS–1.15:101971;CONF-8902124–: 18. annual symposium on applied vacuum science and technology, Clearwater Beach, FL (USA), 6-8 Feb 1989). Available from NTIS, PC A03/MF A01.

Atomic oxygen is the predominant species in low-Earth orbit between the altitudes of 180 and 650 km. These highly reactive atoms are a result of photodissociation of diatomic oxygen molecules from solar photons having a wavelength less than or equal to 2430A. Spacecraft in low-Earth orbit collide with atomic oxygen in the 3P ground state at impact energies of approximately 4.2 to 4.5 eV. As a consequence, organic materials previously used for high altitude geosynchronous spacecraft are severely oxidized in the low-Earth orbital environment. The evaluation of materials durability to atomic oxygen requires ground simulation of this environment to cost effectively screen materials for durability. Directed broad beam oxygen sources are necessary to evaluate potential spacecraft materials performance before and after exposure to the simulated low-Earth orbital environment. This paper presents a description of a low energy, broad oxygen ion beam source used to simulate the low-Earth orbital atomic oxygen environment. The results of materials interaction with this beam and comparison with actual in-space tests of the same meterials will be discussed. Resulting surface morphologies appear to closely replicate those observed in space tests.

47440 (N–89-21256) **Study of the stress wave factor technique for evaluation of composite materials. Final report.** Duke, J.C. Jr.; Henneke, E.G. II; Kiernan, M.T.; Grosskopf, P.P. Virginia Polytechnic Inst. and State Univ., Blacksburg, VA (USA). Jan 1989. 61p. (NASA-CR–4195;E–4385;NAS–1.26:4195). Available from NTIS, PC A04/MF A01.

The acousto-ultrasonic approach for nondestructive evaluation provides a measurement procedure for quantifying the integrated effect of globally distributed damage characteristic of fiber reinforced composite materials. The evaluation procedure provides a stress wave factor that correlates closely with several material performance parameters. The procedure was investigated for a variety of materials including advanced composites, hybrid structure bonds, adhesive bonds, wood products, and wire rope. The research program focused primarily on development of fundamental understanding and applications advancements of acousto-ultrasonics for materials characterization. This involves characterization of materials for which detection, location, and identification of imperfections cannot at present be analyzed satisfactorily with mechanical performance prediction models. In addition to presenting definitive studies on application potentials, the understanding of the acousto-ultrasonic method as applied to advanced composites is reviewed.

47441 (N–89-21286) **Strain energy release rate as a function of temperature and preloading history utilizing the edge delamination fatique test method. Contractor resepor, July 1986-October 1988.** Zimmerman, R.S.; Adams, D.F. Wyoming Univ., Laramie, WY (USA). Feb 1989. 270p. (NASA-CR–184966;NAS–1.26:184966;UW-CMRG-R–89-106). Available from NTIS, PC A12/MF A01.

Static laminate and tension-tension fatigue tests of IM7/8551-7 composite materials was performed. The Edge Delamination Test (EDT) was utilized to evaluate the temperature and preloading history effect on the critical strain energy release rate. Static and fatigue testing was performed at room temperature and 180 F (82 C). Three preloading schemes were used to precondition fatigue test specimens prior to performing the normal tension-tension fatigue EDT testing. Computer software was written to perform all fatigue testing while monitoring the dynamic modulus to detect the onset of delamination and record the test information for later retrieval and reduction.

47442 (N–89-21726, pp. 30) **Electron mobility in mercury cadmium telluride.** Patterson, J.D. Alabama Univ., University, AL (USA). Dec 1988. (NASA-CR–183553;NAS–1.26:183553;CONF-8806391–: NASA/ASEE summer faculty fellowship program, Huntsville, AL (USA), 6 Jun 1988). In *Research Reports: 1988 NASA/ASEE Summer Faculty Fellowship Program.* Available from NTIS, PC A99/MF E03.

A previously developed program, which includes all electronic interactions thought to be important, does not correctly predict the value of electron mobility in mercury cadmium telluride particularly near room temperature. Part of the reason for this discrepancy is thought to be the way screening is handled. It seems likely that there are a number of contributors to errors in the calculation. The objective is to survey the calculation, locate reasons for differences between experiment and calculation, and suggest improvements.

47443 (PB–89-865505/XAB) **Photochromic polymers. January 1973-June 1989 (Citations from the Rubber and Plastics Research Association data base). Report for January 1973-June 1989.** National Technical Information Service, Springfield, VA (USA). Jul 1989. 55p. Available from NTISPC N01/MF N01.

Supersedes PB–88-861760.

This bibliography contains citations concerning synthesis, properties, and reactions of photochromic polymers. Radiation and thermal effects on photochromic properties of polymers are discussed. The uses of photochromic materials in eyeglasses, spectacle lenses, photographic optics and laser optics, are described. (This updated bibliography contains 98 citations, 11 of which are new entries to the previous edition.)

47444 (SAND–88-3338C) **The SANDIA standard for PVDF [polyvinylidene di-fluoride] shock sensors.** Reed, R.P.; Graham, R.A.; Moore, L.M.; Lee, L.M.; Fogelson, D.J.; Bauer, F. Sandia National Labs., Albuquerque, NM (USA). 1989. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-890812–11: American Physical Society topical conference on shock compression of condensed matter, Albuquerque, NM (USA), 14-17 Aug 1989). Order Number DE89016530/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A formal consensus standard for a version of the generic Bauer PVDF shock stress sensor is being defined by a panel broadly experienced in the techniques of PVDF sensor application. The evolving standard addresses points essential to accurate shock measurement with PVDF gauges. It covers the materials, dimensions, proportions, processing, inspection, calibration, certification, tolerances, and application for PVDF elements. The formal standard will be available for voluntary use by the shock stress community as a guide for selection procurement, application, and analysis of this useful new shock measurement tool. 4 refs.

47445 (SAND–89-0661C) **Theory of calcite equation of state.** Kerley, G.I. Sandia National Labs., Albuquerque, NM (USA). 1989. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-890812–26: American Physical Society topical conference on shock compression of condensed matter, Albuquerque, NM (USA), 14-17 Aug 1989). Order Number DE89016884/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Tabular equations of state (EOS) are constructed for both dry and wet calcium carbonate rocks and minerals. The calculations use a multiphase-multicomponent chemical equilibrium model that explicitly treats solid-solid phase transitions, melting, and reactio between water and rock. The results give good agreement with experimental data for the phase boundaries, static compressibilities, Hugoniots and shock wave profiles. 8 refs., 6 figs.

47446 (SAND–89-0814C) **Field-assisted bonding of single crystal quartz.** Watkins, R.D.; Tuthill, C.D.; Curlee, R.M.; Koehler, D.R.; Joerg, C.F. Sandia National Labs., Albuquerque, NM (USA). [1989]. 27p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-8908132–1: 11. quartz devices conference, Kansas City, MO (USA), 28-31 Aug 1989). Order Number DE89015407/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A technique to produce strong, hermetic bonds between plates of single crystal quartz using a modified field-assisted bonding process

is presented. Field-assisted bonding is a technique traditionally used to join glass to metals at temperatures well below normal glass softening temperatures. To promote reactivity between quartz within an electrical field at temperatures well below quartz transformation temperatures, thin films of silicon metal and glass were vapor deposited onto adjacent quartz plates. Thermal stresses caused by expansion mismatch between the quartz and the films were of concern. These stresses were reduced by determining the minimum film thicknesses capable of yielding sufficient reactivity for bonding. Processing studies were conducted to optimize bond integrity, and bonds were characterized by hermeticity, thermal shock, and mechanical shock. Packages produced under the most ideal conditions were able to survive greater than 1000 psi shock loads. 11 refs., 10 figs., 3 tabs.

47447 (SAND–89-1116C) **Strain and density dependent valence-band masses in InGaAs/GaAs and GaAs/GaAsP strained-layer structures.** Jones, E.D.; Biefeld, R.M.; Klem, J.F.; Lyo, S.K. Sandia National Labs., Albuquerque, NM (USA). [1989]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-8909185–1: 16. symposium on gallium arsenide and related compounds, Karuizawa (Japan), 25-29 Sep 1989). Order Number DE89016882/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Low-temperature magnetoluminescence measurements have been performed in several n-type InGaAs/GaAs single-strained-quantum-wells with varying internal strain and a n-type GaAs/GaAsP strained-layer-superlattice. Using newly discovered selection rules, an analysis of the data yields simultaneous information about the conduction and valence-band dispersion curves from a single sample. We find that the conduction-bands are parabolic for all of our structures, with effective mass in the range of 0.068 to $0.074m_0$. The valence-bands are found to be nonparabolic and strain dependent. A simple two-band model is used to analyze the nonparabolicity in terms of a zone-center mass m and a parameter C which is expressed in terms of the light-hole and heavy-hole energy difference. From the two-band model, predictions for the valence-band mass as a function of the 2D-carrier concentration can be made. These predictions are found to be in good agreement with recent cyclotron resonance measurements of the mass in p-type samples. 10 refs., 6 figs., 1 tab.

47448 (SAND–89-1829C) **Suppression of volume breakdown in vacuum with coatings.** Buttram, M.T. Sandia National Labs., Albuquerque, NM (USA). 1989. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-8906200–1: Large area electron beam diode workshop, Monterey, CA (USA), 7 Jun 1989). Order Number DE89016176/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Thin cathode coatings have been shown to be effective in suppressing pulsed breakdown in vacuum. Coatings are normally plastics, although some inorganics have been used. Thicknesses range from on the order of a micron to several mils (1 mil = 25.4 μm). Pulse lengths from 10 ns to more than 1 μs have been studied. 2 refs., 3 figs.

47449 Ion beam processes in advanced electronic materials and device technology. Materials Research Society symposia proceedings. Volume 45. Appleton, B.R.; Eisen, F.H.; Sigmon, T.W. 393p. Materials Research Society, Pittsburgh, PA (1985). (CONF-850421–: 2. spring meeting of the Materials Research Society, San Francisco, CA (USA), 15-18 Apr 1985).

These proceeding collect papers on ion beams and materials science. topics include: amorphous silicon layer regrowth, damage induced by ion implantation, magnetic properties of implantedious, formation of amorphous silicon by ion damage, ion beam mixing, hydrogen ion beam passivation of electrically active defects in soar cells, and annealing of silicon and beryllium-implanted gallium arsenide.

47450 Oxygen, carbon, hydrogen and nitrogen in crystalline silicon. Materials Research Society symposia proceedings. Volume 59. Mikkelsen, J.C.; Pearton, S.J.; Corbett, J.W.; Pennycook, S.J. 579p. Materials Research Society, Pittsburgh, PA (1986). (CONF-8512141–: Oxygen, carbon, hydrogen and nitrogen in crystalline silicon, Boston, MA (USA), 2-5 Dec 1985).

These proceedings collect papers on interstitial material in silicon. Topics include: hydrogen in crystalline silicon, low energy hydrogen ion bombarded silicon, oxygen in silicon, oxygen thermal donor formation, thermal donor generation and annihilation effects on oxygen precipitation oxygen effects on plastic flow during growth of dendrixic web silicon, nitrogen in silicon, off-center nitrogen and oxygen in silicon, and thermal donor hierarchies in silicon and germanium.

47451 The role of trapped interstitials during rapid thermal annealing. Pennycook, S.J. (Solid State Div., Oak Ridge National Lab., Oak Ridge, TN (US)); Culbertson, R.J. vp of Rapid thermal processing. Sedgwick, T.O.; Seidel, T.E.; Tsaur, B-Y, Materials Research Society, Pittsburgh, PA (1986). (CONF-851217–: Materials Research Society meeting, Boston, MA (USA), 2-7 Dec 1985).

During the rapid thermal annealing of ion implanted layers, trapped interstitials are responsible for transient enhance dopant diffusion and the formation of a band of defects at the mean projected ion range. The authors describe the detailed nature and extent of these effects and show how they can be predicted in practice. They present a model which explains why trapping only occurs with group V implantation and describe double implantation experiments with confirm the model and show how the formation of projected range defects can be suppressed.

47452 Electronic properties of liquid silicon. Broughton, J.Q. (State Univ. of New York at Stony Brook, Stony Brook, NY (US)); Allen, P.B. vp of Computer-based microscopic description of the structure and properties of materials. Broughton, J.; Krakow, W.; Pantelides, S.T. Materials Research Society, Pittsburgh, PA (1986). (CONF-851217–: Materials Research Society meeting, Boston, MA (USA), 2-7 Dec 1985).

The electronic properties of liquid silicon were computed by coupling molecular dynamics and tight binding methods. By employing the Stillinger-Weber potential, atomic configurations of liquid Si at 1740^0 were generated by molecular dynamics. Tight binding parameters chosen to fit fcc, bcc, simple cubic and diamond cubic band structures of silicon, were then used to obtain the electronic properties of the system. All states within 10eV of the Fermi level are found to be delocalized, the density of state spectrum similar (but much broadened) to that of a diamond cubic silicon and the optical conductivity is found to be almost featureless with no Drude behavior.

47453 Surface structure of silica glasses by molecular dynamics simulations. Levine, S.M. (Rutgers Univ., Dept. of Ceramics, Piscataway, NJ (US)); Garofalini, S.H. vp of Defects in glasses. Galeener, F.L.; Griscom, D.L.; Weber, M.J. Materials Research Society, Pittsburgh, PA (1986). (CONF-851217–: Materials Research Society meeting, Boston, MA (USA), 2-7 Dec 1985).

Molecular dynamics computer simulations were used to study surfaces of pure silica glass. The potentials used here were those previously established to model bulk silica and have been extended to study surface relaxation in a perfect vacuum. A large number of surfaces were made using different starting configurations; system sizes, and cooling procedures. Following fracture, many broken bonds rearranged in response to the changes in the net forces in the surface region. After this reconstruction, the simulations showed the expected general features observed experimentally, such as a prevalence of oxygen atoms at the outermost surface, non-bridging oxygens, and strained siloxane bonds. Three fold silicons (similar to e' centers) were initially present in the fractured surfaces but most often were incorporated into the network tetrahedrally after reconstruction. Other defects produced during the reconstruction were five coordinated silicons and more importantly, edge sharing tetrahedra, forming the strained siloxane bonds.

47454 Investigation of impurity neutralization and defect passivation in polycrystalline silicon solar cells. Kazmerski, L.L. (Solar Energy Research Institute, Golden, CO (US)). vp of Polysilicon films and interfaces. Wong, C.Y.; Tu, K.N.; Thompson, C.V. Materials Research Society, Pittsburgh, PA (1988). (CONF-8712118–: Polysilicon films and interfaces symposium, Boston, MA (USA), 1-3 Dec 1987).

The passivation of grain boundaries and the neutralization of impurities in polycrystalline silicon, important processes for the improvement of performance of devices fabricated from this material, are discussed. The incorporation of hydrogen into grain boundaries

is investigated using surface analysis methods. Volume-mapping techniques are used to identify the bonding mechanisms of the hydrogen in oxygen-free and oxygen-rich intergrain regions. Interactions between shallow acceptors (B,Al,Ga and In) and hydrogen in polycrystalline Si are studied. The bonding mechanisms involved in the acceptor neutralization process at the grain boundaries are evaluated using microanalytical techniques. Differences in the incorporation of molecular and atomic hydrogen, and corresponding variation in electrical passivation of grain boundaries, are observed. Volume-indexed AES and Auger difference spectroscopy data are complemented by scanning tunneling microscope images to confirm the direct hydrogen-silicon bonding in boron-doped grain boundaries.

47455 Monte Carlo simulation of growth of crystalline and amorphous silicon. Dodson, W. (Sandia National Labs., Albuquerque, NM (US)); Taylor, P.A. vp of Computer-based microscopic description of the structure and properties of materials. Broughton, J.; Krakow, W.; Pantelides, S.T. Materials Research Society, Pittsburgh, PA (1986). (CONF-851217–: Materials Research Society meeting, Boston, MA (USA), 2-7 Dec 1985).

The authors have applied the method, initially used to simulate growth of two-dimensional Lennard-Jones systems, to treat growth of silicon in three dimensions. The interaction model for silicon is taken to be the recently introduced Stillinger-Weber (S-W) potential, which is a two- and three- body classical potential. Although the early stages of growth seem to be well modelled by the S-W potential, growth of even a single monolayer of epitaxial (111) silicon does not seem to be possible. Modifications to the S-W potential were considered, and found to be unacceptable physically. More accurate treatment of non-ideal atomic configuration energies is necessary to arrive at physically realistic growth simulations.

47456 EBIC evidence for carbon-based gettering in EFG silicon. Kalejs, J.P. (Mobil Solar Energy Corp., Waltham, MA (US)); Gleichmann, R.; Ast, D.G. vp of Impurity diffusion and gettering in silicon. Fair, R.B.; Pearce, C.W.; Washburn, J. Materials Research Society, Pittsburgh, PA (1985). (CONF-841157–: Materials Research Society annual meeting, Boston, MA (USA), 26-29 Nov 1984).

The efficiency of solar cells fabricated from low-oxygen high-carbon, EFG silicon ribbon can be improved by per-annealing the ribbon at 1200^{0}C prior to processing. TEM analysis shows that the increased efficiency is not related to a relaxation of the defect structure. Rather, EBIC investigations demonstrate a continuous reduction of the recombination activity of in-grown crystal defects (dislocations, grain boundaries) with increasing duration of the anneal. Since C is the only element in supersaturation at the annealing temperature, a model is suggested in which metallic contaminants are gettered at small carbon clusters.

47457 Transient enhanced diffusion and gettering of dopants in ion implanted silicon. Pennycook, S.J. (Oak Ridge National Lab., Oak Ridge, TN (US)); Narayan, J.; Culbertson, R.J. vp of Impurity diffusion and gettering in silicon. Fair, R.B.; Pearce, C.W.; Washburn, J. Materials Research Society, Pittsburgh, PA (1985). (CONF-841157–: Materials Research Society annual meeting, Boston, MA (USA), 26-29 Nov 1984).

The authors have studied in detail the transient enhanced diffusion observed during furnace or rapid-thermal-annealing of ion-implanted si. They show that the effect originates in the trapping of Si atoms by dopant atoms during implantation, which are retained during solid-phase-epitaxial (SPE) growth but released by subsequent annealing to cause a transient dopant precipitation or profile broadening. The interstitials condense to form a band of dislocation loops located at the peak of the dopant profile, which may be distinct from the band formed at the original amorphous/crystalline interface. The band can develop into a network and effectively getter the dopant. The authors discuss the conditions under which the various effects may or may not be observed, and discuss preliminary observation on As$^+$ implanted Si.

47458 Effect of pressure on self diffusion in crystalline silicon. Aziz, M.J. (Oak Ridge National Lab., Oak Ridge, TN (US)); Christie, W.H.; White, C.W.; Nygren, E.; Turnbull, D. vp of Impurity diffusion and gettering in silicon. Fair, R.B.; Pearce, C.W.; Washburn, J. Materials Research Society, Pittsburgh, PA (1985). (CONF-841157–: Materials Research Society annual meeting, Boston, MA (USA), 26-29 Nov 1984).

The effect of pressure on self diffusion in crystalline silicon is being studied using ^{30}Si as a tracer. Diffusion experiments have been carried out in the pressure range of 1 to 3500 atmospheres at 1000c. The ^{30}Si is observed to diffuse faster at high pressures, indicating a negative activation volume.

47459 Imaging of coronary arteries using synchrotron radiation. Thompson, A.C. (Lawrence Berkeley Lab., CA (USA). Center for X-Ray Optics); Zeman, H.; Thomlinson, W.; Rubenstein, E.; Kernoff, R.S.; Hofstadter, R.; Giacomini, J.C.; Gordon, H.J.; Brown, G.S. *Nuclear Instruments and Methods in Physics Research, Section B: Beam Interactions with Materials and Atoms (Netherlands)*, 40/41(pt.1): 407-412 (Apr 1989). (CONF-881151–: 10. international conference on the application of accelerators in research and industry, Denton, TX (USA), 7-9 Nov 1988).

Currently the imaging of coronary arteries is dangerous since it requires that a catheter be inserted into a peripheral artery and threaded up to the heart so that contrast agent can be injected directly into the artery being imaged. Using synchrotron radiation it may be possible to use a much safer venous injection of a contrast agent and still have sufficient image constrast to visualize the coronary arteries. A pair of monochromatized X-ray beams are used which have energies that bracket the iodine K absorption edge where the iodine absorption cross section jumps by a factor of six. Therefore, the logarithmic difference image has excellent sensitivity to contrast agent and minimal sensitivity to tissue and bone. Images have been taken of both dogs and humans. Improvements are being made to the imaging system which will substantially improve the image quality. (orig.).

40 CHEMISTRY

Refer also to citation(s) 47238, 48263

47460 (ORNL–6555) **Chemistry Division annual progress report for period ending March 31, 1989.** Oak Ridge National Lab., TN (USA). Aug 1989. 213p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89015647/JAW. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

The Chemistry Division carries out long-range fundamental research in areas of chemistry that are relevant to future energy technologies. It also conducts some shorter-range studies in cases for which the expertise of its staff and its facilities are appropriate. The scope of the research includes physical chemistry, inorganic and organometallic chemistry, organic chemistry, geochemistry, surface science, and polymer science; however, analytical chemistry is organizationally separate at ORNL. This report contains descriptions of recent progress. Selected highlights are listed below.

4001 Analytical and Separations Chemistry

Refer also to citation(s) 46836, 46920, 47085, 47481, 47534, 47555, 47640, 47660, 47661, 48193

47461 (BNL–43048) **The application of synchrotron radiation to microprobe trace element analysis of biological samples.** Gordon, B.M.; Hanson, A.L.; Jones, K.W.; Pounds, J.G.; Rivers, M.L.; Schidlovsky, G.; Spanne, P.; Sutton, S.R. Brookhaven National Lab., Upton, NY (USA). 1989. 18p. Sponsored by DOE/ER;DOHHS. DOE Contract AC02-76CH00016. P41RR01838. (CONF-8906161–6: Ion beam analysis conference, Kingston (Canada), 26-30 Jun 1989). Order Number DE89017622/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An x-ray fluorescence microprobe (XRM) for trace element analysis is in operation at the National Synchrotron Light Source of Brookhaven National Laboratory. The properties of synchrotron radiation, in this case a continuous spectrum of x rays ranging up to 40 keV, make possible its uses as a microprobe beam with collimation or focusing with appropriate optical elements. Sensitivities in thin

samples at 10 × 10 μm^2 spatial resolution is of the order of 10 fg using filtered, collimated "white light" and about 3 fg using a Kirkpatrick-Baez (KB) focusing system in thin standard foil. Results using a newly installed ellipsoidal mirror will be described. A discussion of standards for microprobe analysis is included. Examples of applications to the life sciences are described. These include the mapping of trace element distributions in thin tissue samples and examples of transmission and fluorescence microtomography. Synchrotron radiation microprobes complement ion and electron beam microprobes and the differences between the methods are considered. 23 figs., 4 tabs.

47462 Profiles of HCO and CH_3 in CH_4/O_2 and C_2H_4/O_2 flames by resonance ionization. Cool, T.A. (Cornell Univ., Ithaca, NY (USA)); Bernstein, J.S.; Song, X.M.; Goodwin, P.M. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). DOE Contract FG02-86ER13508. From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Measurements are presented of the relative density profiles of formyl and methyl radicals in stoichiometric methane/oxygen and ethylene/oxygen flames which exemplify recent progress in the use of resonance-enhanced multiphoton ionization (REMPI) spectroscopy for flame diagnostics. The advantages and present limitations of this new laser-based technique are discussed. The high sensitivity of the REMPI method for the detection of HCO presents an opportunity for better measurements of flame profiles and of the rate constants for consumption of this important intermediate in hydrocarbon combustion.

47463 Resonantly enhanced multiphoton ionization for the trace detection of chlorinated aromatics. Rohlfing, E.A. (Sandia National Laboratories, Livermore, CA (USA)). pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

There is currently a need for a technique to detect chlorinated aromatics in the gas phase, for example in the exhaust stream of an incinerator. This paper presents the results of investigations into a laser-based scheme that is ultrasensitive, species- and isomer-selective, and quasi-real-time. The approach is to use free-jet-expansion cooling to narrow the resonantly enhanced multiphoton ionization (1 + 1 REMPI) spectrum and to allow isomerically selective laser excitation via the first electronically excited singlet state. The photoions are mass analyzed in a reflectron time-of-flight mass spectrometer (TOF MS) that has a resolution (M/ΔM) of ~600 at mass 150. Ppb level detection limits with complete isomeric selectivity are achieved for the dichlorobenzenes using the jet-cooled REMPI/TOF MS technique. The applicability of this detection scheme to more complicated toxic species, such as PCB's, dioxins, and furnas, are discusses and ideas for a device that could be used for quasi-real-time detection in a typical working environment are presented.

47464 Measurements of nitrogen Q-branch foreign gas-broadening coefficients relevant to flames. Rahn, L.A. (Sandia National Laboratories, Livermore, CA (USA)); Farrow, R.L. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The J-dependent line-broadening coefficients for the Raman Q-branch of nitrogen in propane and n-butane at 296 K and in water vapor at 1570 K have been measured using high-resolution inverse Raman spectroscopy. Predictions of a modified exponential energy-gap fitting way are compared with partially rotationally collapsed spectra of nitrogen in the two fuel gases.

47465 The quantitative LIF (laser-induced fluorescence) determination of OH concentrations in low-pressure flames. Kohse-Hoeinghaus, K. (SRI International, Menlo Park, CA (USA)); Jeffries, J.B.; Copeland, R.A.; Smith, G.P.; Crosley, D.R. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Laser-induced fluorescence (LIF) of OH is used to measure spatially resolved temperature and concentration profiles in premixed laminar flames of H_2 burning in mixtures of O_2 and N_2O at 7.2 Torr. Potential sources of error in such measurements are investigated: optical depth; the detector spectral bias, time delay, and sampling gate; and rotational level dependence of the quantum yield for the OH radical. The authors explicitly demonstrate differences between LIF intensity measurements and the actual OH concentration profiles caused by the temperature dependence of the rotational level populations across the flame front. By varying the proportion of O_2 and N_2O in stoichiometric flames, burnt gas temperatures between 1200 and 2300 K are obtained. Quenching measurements in the burnt gases of these flames show that quenching by atomic hydrogen can be important. In the burnt gases of the H_2/N_2O flame, the quenching does not significantly depend on rotational level for diagnostics with 5% accuracy. However, in the chemically interesting and important flame front, there is a significant variation in the quantum yield with rotational level, and in the flame front of atmospheric pressure flames such quantum yield corrections are likely to be important.

47466 NH and CH laser-induced fluorescence in low-pressure flames: Quantum yields from time-resolved measurements. Rensberger, K.J. (SRI International, Menlo Park, CA (USA)); Copeland, R.A.; Wise, M.L.; Crosley, D.R. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Time-resolved laser-induced fluorescence measurements of the total removal rate constants for the $v' = 0$ vibrational level of electronically excited states of the NH and CH radicals are obtained in a variety of low-pressure (5 to 25 Torr) flames. The NH($A^3\Pi_i$) removal rate constants are examined for flames containing N_2O as an oxidizer and source of nitrogen. The NH fluorescence quantum yields decrease in the early portion of the flame where the temperature is lower, and become constant farther away from the burner. For CH, the $B^2\Sigma^-$ removal rate constant is about 70% faster than that of the $A^2\Delta$ in several hydrocarbon/oxygen stoichiometric flames; both rates do not vary significantly from flame to flame. The CH removal rate constants for both electronic states are constant or show a slight increase from the burner surface into the burnt gases for all the flames. Temperature profiles are obtained using excitation scans over several rotational levels for Ch and NH. Upper limits and estimates for collider specific quenching cross sections for H_2O, N_2, CO_2, and several fuel species are extracted. Collisional energy transfer is observed from the $B^2\Sigma^-$ to the $A^2\Delta$ state of CH. Quantitative measurements show this process has useful diagnostic applications.

47467 Discussion of two-photon laser-excited fluorescence as a method for quantitative detection of oxygen atoms in flames. Meier, U. (DFVLR-Institut fuer Physikalische Chemie der Verbrennung, Stuttgart (West Germany)); Bittner, J.; Kohse-Hoeinghaus, K.; Just, T. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Spatially resolved measurements of absolute oxygen atom concentrations in low-pressure $H_2/O_2/Ar$-, CH_4/O_2- and C_2H_2/O_2 flames are performed by two-photon laser excited fluorescence. The measured signals are converted into O atom number densities using a calibration technique, based on the comparison of fluorescence signals in a flame with those in a discharge flow reactor. This procedure requires consideration of quenching processes; furthermore, the influence of photoionization and potential photodissociation of flame gases must be considered. The sensitivity of the derived concentrations to experimental parameters and atomic quantities is discussed.

47468 Determination of relative number density and decay rate for atomic sodium in an atmospheric premixed flame by Asynchronous Optical Sampling. Fiechtner, G.J. (Purdue Univ., West Lafayette, IN (USA)); Jiang, Yanan; King, G.B.; Laurendeau, N.M.; Kneisler, R.J.; Lytle, F.E. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Asynchronous Optical Sampling (ASOPS) is a pump/probe method that utilizes a dual timebase scheme to determine number

densities and decay rates. In the ASOPS technique, two lasers are mode-locked at slightly different frequencies, causing a relative phase walk-out between the pump and probe lasers. This allows the dynamic measurement of subnanosecond excitation processes in a time scale on the order of milliseconds. The current ASOPS instrument consists of two dye lasers synchronously pumped by two frequency-doubled Nd:YAG lasers at a repetition rate of ~82 MHz. The ASOPS signal is obtained by AC amplification of the probe beam voltage, which is measured by a single photodiode at a beat frequency of 10 kHz. In this paper the authors report the first use of ASOPS in a flame environment. The relative number density and decay time of atomic sodium are measured by aspirating a sodium chloride solution into an atmospheric premixed CH_4/O_2N_2 flame. The pump and probe beams are each tuned to the D_2 transition (589.0 nm). Both ASOPS and laser-induced fluorescence are used to determine relative concentration profiles and saturation curves. Measurements obtained using these techniques are found to be in close agreement, demonstrating the viability of the ASOPS method as a combustion diagnostic and its potential for use in high-pressure, turbulent flames.

47469 Application of two-component phase Doppler interferometry to the measurement of particle size, mass flux, and velocities in two-phase flows. McDonell, V.G. (Univ. of California, Irvine (USA)); Samuelsen, G.S. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The application of two-component interferometry is described for the spatially-resolved measurement of particle size, velocity and mass flux as well as continuous phase velocity. Such a capability is important to develop an understanding of the physical processes attendant to two-phase flow systems, especially those involving liquid atomization typical of a wide class of combustion systems. Adapted from laser anemometry, the technique (phase Doppler interferometry) measures single particle events at a point in the flow. Droplet size is deduced from the spatial phase shift of the Doppler signal. Combined with conventional laser anemometry for the resolution of velocity, the added capability of sizing allows for the discrimination of the discrete phase velocity statistics from those of the continuous phases as well as the particle mass flux. Applications are presented for four cases: an example of the discrimination of two sizes of glass beads in a jet flow, a demonstration of the discrimination of phases in a spray field, an assessment of atomizer symmetry with respect to fuel distribution, and a characterization of a droplet field in a reacting spray. In addition, the limits of applicability are discussed.

47470 Analysis of diesel sprays through two-dimensional laser light scattering. Cavaliere, A. (Universita di Pisa (Italy)); Ragucci, R.; D'Alessio, A.; Noviello, C. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Two-dimensional laser light scattering has been used in the study of atomization and dispersion processes of unsteady diesel sprays. Main features, calibrations and digital procedures of the technique have been presented and its diagnostics limits for dense sprays have been discussed in relation to test experiments performed on single droplets and dilute sprays. It has been preliminarily shown that the technique, taking advantage of its quantitative recording of calibrated scattering intensity, yields the evaluation or the signature of total surface area of the liquid according as the spray is dilute or dense. Furthermore is has been shown that the visual examination of the scattering patterns from sections perpendicular to spray could be synthetized by two parameters, describing atomization and dispersion level, which are obtained by digital image processing. The synoptic analysis of these two parameters, determined for a single-hole diesel spray injected into a quiescent atmospheric environment, have evidenced different atomization regimes in different space-time positions. During the needle lift the fuel is fragmented at the nozzle outlet, whereas during the needle shut off the atomization is a continuous process which evolves in a large space range. The main part of the liquid is fragmented, also in the inner region of the jet, at a distance from the nozzle (break-up length) shorter than that measured on stationary sprays. It is shown that unsteady fluid-dynamics of the liquid jet inside and outside the nozzle is essential in giving tentative mechanisms of atomization regimes and that time-varying injection effects are relevant to the knowledge of diesel combustion processes.

47471 (DOE/ER/45163–12) **X-ray and γ-ray spectroscopy of solids under pressure: Annual technical progress report, October 1988–October 1989.** Ingalls, R.L. Washington Univ., Seattle, WA (USA). Dept. of Physics. 30 Jun 1989. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract FG06-84ER45163. Order Number DE89017271/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This report summarizes studies of various materials at high pressures by means of x-ray and γ-ray absorption spectroscopy. It is to be recalled that pressure is a fundamental thermodynamic variable. In particular it enables one to control the state of the material, such as liquid or solid, insulating or conducting, para- or ferromagnetic, etc. We have developed such techniques suitable for use with synchrotron radiation such as at the Stanford Synchrotron Radiation Laboratory (SSRL).

47472 (DP-MS–89-33) **Computerized procedure for preparation of secondary standards.** O'Rourke, P.E. Westinghouse Savannah River Co., Aiken, SC (USA). 1989. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC09-89SR18035. (CONF-890736–66: 30. annual meeting of the Institute of Nuclear Materials Management, Orlando, FL (USA), 9-12 Jul 1989). Order Number DE89017853/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Laboratory quality control programs depend on the analysis of known standards to judge the accuracy and reliability of the results they generate. The standards used for routine checks are generally made by diluting and mixing well characterized and traceable primary standards because the primary standards are too expensive and difficult to certify to use in large quantities. We have developed a computer program to help automate the production of secondary standards and to help assure their accuracy and reliability. The program performs four major functions: input and tracking of information about primary stock standards; input and editing of procedures to make secondary standards from available stock standards; calculation of secondary standard concentrations and uncertainties based on weights and densities; and inventory of components in stock standards, secondary standards, and waste. The reliability of the secondary standards is verified by testing measured secondary standard density against its calculated density. Secondary standard uncertainties are calculated by propagating the uncertainties of the stock standard concentrations and weight and density measurements. Weight and density measurements can be automatically transmitted from instruments with RS-232 interfaces or manually entered. 1 fig.

47473 (INIS-mf–11515, pp. 125) **Variant of the thermoluminescence method for sediment age estimation.** Wallner, G. (Vienna Univ. (Austria). Inst. fuer Radiumforschung und Kernphysik); Wild, E.; Aref-Azar, H.; Hille, P.; Schmidt, W. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47474 (INIS-mf–11515, pp. 126) **Radio-, Lyo- and Triboluminescence in $CaCO_3$ and NaCl.** Wergles, K. (Vienna Univ. (Austria). Inst. fuer Radiumforschung und Kernphysik); Nowotny, R.; Hille, P. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47475 (INIS-SU–107/A, pp. 239) **Complexone application to sample preparation for an x-ray fluorescence analysis.** Bour-Moskalenko, Z.O. (Khar'kovskij Gosudarstvennyj Univ., Kharkov

(Ukrainian SSR)); Lebedev, V.N. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413--: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.

'Short Communication.'

47476 (INIS-SU--107/A, pp. 315) **Rapid technique of vanadium (4), determination in the presence of vanadium (5).** Kurbatova, L.D. (AN SSSR, Sverdlovsk (USSR). Inst. Khimii); Zabolotskaya, E.V. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413--: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.

'Short Communication.'

47477 (IWGFPT--31, pp. 23-28) **Actual experience in burnup determination of mixed oxide fuel.** Regge, P. de (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)); Huys, D.; Boden, R.; Ballaux, C. International Atomic Energy Agency, Vienna (Austria). International Working Group on Water Reactor Fuel Performance and Technology. May 1989. (CONF-8806392--: IAEA technical committee meeting on burnup determination of water reactor fuel, Karlsruhe (Germany, F.R.), 13-16 Jun 1988). In *Burnup determination of water reactor fuel. Proceedings of a technical committee meeting held in Karlsruhe, 13-16 June 1988.* Order Number DE90601639/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

The current radiochemical techniques used at SCK/CEN for the destructive burnup determination of mixed oxide fuels are reviewed. The procedure for fuel sampling and dissolution, for the chemical separations and the mass-spectrometric and radiochemical measurements are briefly described. The concentrations of uranium and plutonium in the fuel are obtained by mass-spectrometric isotopic dilution using ^{233}U- and ^{242}Pu-spikes. Neodymium is determined by mass spectrometric isotopic dilution using a ^{146}Nd spike and ^{147}Nd as a tracer in the chemical separations. The transplutonium elements and the gamma-ray emitting fission products are determined by alpha- and gamma-ray spectrometry, respectively the calculation method to obtain the weighted fission yields averaged over the irradiation period is commented. The procedure contains several cross-checking points where the consistency of the data is evaluated and thereby provides virtually a number of independent burnup measurements, increasing both the reliability and the accuracy of the results. Typical results obtained for MOX fuels in thermal recycling and fast breeder reactor fuels are presented as well as data on the radial distribution of burnup, fissionable nuclides and fission products. (author). 5 refs, 4 figs, 4 tabs.

47478 (IWGFPT--31, pp. 32-36) **Determination of radial gadolinium burnup in LWR fuel by secondary ion mass spectrometry (SIMS).** Zwicky, H.U. (Paul Scherrer Inst. (PSI), Wuerenlingen (Switzerland)); Aerne, E.T.; Bart, G.; Thomi, H.A.; Sherwin, J. International Atomic Energy Agency, Vienna (Austria). International Working Group on Water Reactor Fuel Performance and Technology. May 1989. (CONF-8806392--: IAEA technical committee meeting on burnup determination of water reactor fuel, Karlsruhe (Germany, F.R.), 13-16 Jun 1988). In *Burnup determination of water reactor fuel. Proceedings of a technical committee meeting held in Karlsruhe, 13-16 June 1988.* Order Number DE90601639/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

The "International Experimental Programme on Gadolinia Fuel Evolution in PWR's (GAP)" is devoted to the acquisition of experimental results in support of studies concerning the use of Gd_2O_3 as a burnable absorber in pressurized water reactors. One of the main tasks of the programme was to evaluate radial isotopic distributions of Gd in irradiated fuel samples. Mass spectrometry following radiochemical separations on samples taken by microdrilling is a laborious technique. Moreover, the lateral resolution is limited by the diameter of the drill. An alternative technique for the measurement of local isotopic compositions is Secondary Ion Mass Spectrometry (SIMS). This method is faster and provides greater lateral resolution. The major disadvantage of the SIMS technique is its limitation concerning quantitative analyses. It is therefore necessary to use average isotopic abundance values evaluated by dissolution and mass spectrometry for the normalization of the SIMS data. Alternatively, isotopic calibration standards with a chemical composition comparable to the fuel samples may be used. Samples of fuel with an initial ^{235}U enrichment of ~3.5% and Gd_2O_3 concentrations of ~3 and ~7 wt% have been analyzed. The burnup values lay between 2 and 6 GWd/tM. Several surface scans of the same sample showed a standard deviation of less than 10% (relative), provided that the residual isotopic abundances were higher than ~1%. Results of radial Gd burnup calculations with the aid of the LWRWIMS code were in good agreement with SIMS evaluated isotopic distributions. (author). 4 refs, 9 figs.

47479 (PB--89-181390/XAB) **Evaluation of high-resolution gas for the determination of 2, 3, 7, 8-TCDD in soil, sediment and water (journal version).** Stanley, J.S.; Sack, T.M.; Tondeur, Y.; Beckert, W.F. Midwest Research Inst., Kansas City, MO (USA). 1988. 12p. Available from NTIS, PC A03/MF A01.

Pub. in Biomedical and Environmental Mass Spectrometry, Vol. 17, 27-35(1988).

An analytical protocol for the determination of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) and total TCDDs in soil, sediment, and aqueous samples using high-resolution gas chromatography/high-resolution mass spectrometry (HRGC/HRMS) was evaluated through replicate analyses of fortified and unspiked soil and aqueous samples. Lower levels of detection can be achieved through a slight modification of the method with respect to initial sample size and/or final extract volume. Instrumental parameters that affect data quality, specifically HRGC column performance, mass resolution, and mass-measurement accuracy are presented.

47480 **Ion microbeam tomography.** Pontau, A.E. (Sandia National Labs., Livermore, CA (USA)); Antolak, A.J.; Morse, D.H.; Ver Berkmoes, A.A.; Brase, J.M.; Heikkinen, D.W.; Martz, H.E.; Proctor, I.D. *Nuclear Instruments and Methods in Physics Research, Section B: Beam Interactions with Materials and Atoms (Netherlands),* 40/41(pt.1): 646-650 (Apr 1989). (CONF-881151--: 10. international conference on the application of accelerators in research and industry, Denton, TX (USA), 7-9 Nov 1988).

Proton beams with energies of 5 and 7 MeV are focused to 5 μm and used to produce tomograms of capillary tubes and low-density foams. In this energy range, proton energy loss is primarily due to interactions with electrons. Therefore, by measuring the residual energy of protons transmitted through samples in a manner similar to that used for Scanning Transmission Ion Microscopy (STIM), and reconstructing a cross-sectional image from multiple projections, we can map out spatial variations in electron density due to sample geometry and composition. In our experimental arrangement, the sample is translated and rotated in a stationary proton beam. Transmitted proton energies are measured using a silicon surface barrier detector. Tomographic reconstructions are produced from the calculated line-average densities using a procedure based on a filtered backprojection algorithm developed for X-ray computed tomography (CT) systems. The technique is especially useful in characterizing samples where large variations in Z or low total density limit the applicability of X-ray CT analysis. (orig.).

4002 Inorganic, Organic and Physical Chemistry

Refer also to citation(s) 46793, 46814, 46824, 47018, 47019, 47022, 47023, 47024, 47025, 47096, 47294, 47347, 47388, 47406, 48523, 48701

47481 (AERE-R-12820(rev.)) **Review of some aspects of the solution chemistry of technetium.** Hughes, M.A.; Rossotti, F.J.C. UKAEA Harwell Lab. (UK). Chemistry Div. Dec 1987. 75p. Available from H.M. Stationery Office, London, price Pound 12.00.

The literature on the chemistry of technetium in solution has been surveyed. Emphasis has been placed on aspects relevant to the conditions of reprocessing nuclear fuels and the disposal of radioactive wastes to a repository. Attention has been paid to the species and oxidation states of technetium reported to be produced by chemical and electrochemical reactions in acidic, neutral and alkaline media. Values of some of the reduction potentials have been summarised as a function of pH in a series of Pourbaix diagrams. Aspects of the extraction of a number of metal ions into TBP have also been considered, with special reference to mixed metal-nitrate-pertechnetate species. (author).

47482 (BNL–42981) **High temperature study of the reaction of $O(^3P) + NH_3$.** Patterson, P.M.; Sutherland, J.W.; Klemm, R.B. Brookhaven National Lab., Upton, NY (USA). [1989]. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-890756–2: 17. international symposium on shock waves and shock tubes (STS-17), Bethlehem, PA (USA), 17-21 Jul 1989). Order Number DE89017614/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Values of the rate constant for the reaction $O(^3P) + NH_3$ were determined by comparing calculated O atom profiles with those obtained experimentally in the temperature range 2069–2459K. Oxygen atoms were generated by thermal decomposition of N_2O. The results were combined with those from previous direct studies (448–1790K) to give the following expression 448–2459K: $k_2(T) = 2.27 \times 10^{-18}\ T^{2.19}\ \exp(-3061/T)\ cm^3\ molecule^{-1}\ s^{-1}$. An overall uncertainty of ±25% is estimated for this expression. 16 refs., 3 figs., 3 tabs.

47483 (DOE/ER/13664–3) **Fundamental studies in charge separation at interfaces in relation to water photolysis: Progress report, January 15, 1987–June 25, 1989.** Hurst, J.K. Oregon Graduate Center, Beaverton, OR (USA). Dept. of Chemical and Biological Sciences. 3 Aug 1989. 28p. Sponsored by U.S. DOE Energy Research. DOE Contract FG06-87ER13664. Order Number DE89017268/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This research program has encompassed three areas of activity directed at understanding: (a) interfacial and transmembrane reactions of amphiphilic redox ions; (b) the molecular dynamics of bilayer membrane-bound chromophores; and (c) reactions of putative homogeneous water-oxidation catalysts. Studies in each of these areas are concerned with fundamental problems associated with development of membrane-based devices for photoconversion. We have sought to identify in structurally unsophisticated, vectorially organized vesicle systems molecular mechanisms of charge separation and recombination across the aqueous-hydrocarbon interface, pathways for transmembrane oxidation-reduction, and dynamic relationships between transmembrane redox and electrolyte diffusion, which is essential to maintaining proper charge balance within the system. Several studies designed to provide information on the ultrastructural organization and physical properties of membrane-bound dopants that will facilitate interpretation of the dynamic behavior have also been initiated. As the initial steps to characterizing catalytic mechanisms, we have compared the physical properties and water-oxidizing capabilities of dimeric μ-oxo ions derived from ruthenium analogs and aquaethylenediaminetetraacetatoruthenium complexes. 16 refs., 11 figs.

47484 (DOE/ER/13781–2) **Studies of supported hydrodesulfurization catalysts: Progress report for period January 1, 1989–December 31, 1989.** Hercules, D.M. Pittsburgh Univ., PA (USA). Dept. of Chemistry. Aug 1989. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER13781. Order Number DE89017317/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The overall objective of the proposal is to investigate the structure/activity relationship for Mo or W based hydrodesulfurization catalysts promoted by Ni or Co and supported on undoped or modified Al_2O_3 and TiO_2 surfaces. Specifically the proposed research focused on the following areas: (1) the study of the mechanism of adsorption of Mo and W oxyanions on Al_2O_3 and TiO_2, (2) quantitative analysis of the distribution of supported Mo and W species present in the catalysts oxidic precursors, (3) the determination of the distribution of Mo (or W) oxidation states in reduced Mo (or W)/TiO_2 (or Al_2O_3) catalysts and correlation of the results with the catalytic activity for various probe reactions, and (4) characterization of the sulfided catalysts and correlation of the Mo and W speciation with HDS activity.

47485 (DOE/ID/12467–3) **Physical chemistry of carbothermic reduction of aluminum: Final report.** Elliott, J.F. Massachusetts Inst. of Tech., Cambridge, MA (USA). Dept. of Materials Science and Engineering. 16 Jun 1989. 180p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG07-83ID12467. Order Number DE89015201/JAW. Available from NTIS, PC A09/MF A01 - OSTI; GPO Dep.

A program of study of carbothermic reduction of aluminum was undertaken to investigate the underlying physical chemistry of reactions and processes. The primary goal of the research was to establish the physicochemical basis by the use of which it may be possible to develop schemes for the production of aluminum by direct carbothermic reduction, thus avoiding the use of electrochemical means such as is exemplified by the Hall-Heroult process. One task of the program was to propose one or more possible schemes, and a specific challenge in the investigation was to determine whether or not a process based on the counter-current shaft furnace could possibly be practical for the production of aluminum. In such a furnace, combustion of a carbonaceous fuel would provide heat required in the process, and carbon would also serve as the reducing agent as is the case for the production of crude iron in the iron blast furnace. 15 refs., 22 figs., 24 tabs.

47486 (INIS-SU–107/A, pp. 15) **ENDOR spectroscopy of admixture ions in crystals of inorganic chlorides.** Akhmin, S.M. (AN SSSR, Kazan (USSR). Fiziko-Tekhnicheskij Inst.); Mejklyar, V.P.; Usachev, A.V.; Yablokov, Yu.V. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.

'Short Communication.'

47487 (INIS-SU–107/A, pp. 153) **Static and dynamic characteristics of cerium ion in ethylsulfates under high pressure.** Galimov, R.M. (AN SSSR, Kazan (USSR). Fiziko-Tekhnicheskij Inst.); Bikchantaev, I.G.; Galyametdinov, Yu.G.; Ovchinnikov, I.V. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.

'Short Communication.'

47488 (INIS-SU–107/A, pp. 159) **ESR of the first members of copper and vanadyl metal chelates of 2-acetylbenzimidazole thiosemicarbazones.** Dorokhova, N.I. (Rostovskij-na-Donu Gosudarstvennyj Univ., Rostov-na-Donu (USSR)); Zaletnov, V.G.; Khokhlov, A.V.; Komissarov, V.N.; Chernyshov, V.A.; Garnovskij, A.D. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5.*

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'Short Communication.'

47489 (INIS-SU–107/A, pp. 179) **Synthesis and investigation of vanadyl (2) coordination compounds with aromatic amino acids.** Shodiev, U.M. (Bukharskij Tekhnologicheskij Inst. Pishchevoj i Legkoj Promyshlennosti, Bukhara (USSR)); Khodzhaev, O.F.; Parpiev, N.A.; Larin, G.M.; Manin, V.V. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
'Short Communication.'

47490 (INIS-SU–107/A, pp. 185) **$MoOCl_3$ interaction with amines in the presence of dithioligands.** Minin, V.V. (AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii); Yankina, L.F.; Tujbaev, M.K.; Rakitin, Yu.V.; Konovalova, A.A.; Larin, G.M. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
'Short Communication.'

47491 (INIS-SU–107/A, pp. 186) **ESR in hydrated lithium and sodium dodecavanadates with vanadium mixed oxidation.** Zolotukhina, L.V. (AN SSSR, Sverdlovsk (USSR). Inst. Khimii); Krushinina, M.V.; Koryakova, O.V.; Ivakin, A.A. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47492 (INIS-SU–107/A, pp. 190) **ESR study of products of ruthenium sulfate interaction with 5-amino-1,2,4-dithiazole-3-thione in sulfuric acid solutions.** Miroshnichenko, I.V. (Moskovskij Inst. Tonkoj Khimicheskoj Tekhnologii, Moscow (USSR)); Golovin, K.A.; Sinitsyn, N.M. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47493 (INIS-SU–107/A, pp. 191) **ESR study of Mo(5) complexes with phosphorus- and arsenic-containing ligands.** Galeev, A.M. (Kazanskij Meditsinskij Inst., Kazan (USSR)); Galeeva, S.I.; Chadaeva, N.A. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47494 (INIS-SU–107/A, pp. 193) **ESR study of aquahumate complexes of iron (3), copper (2), manganese (2), vanadium (4), and chromium (3).** Pilipenko, A.T. (AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Kolloidnoj Khimii i Khimii Vody); Vasil'ev, N.G.; Trachevskij, V.V.; Nosonovich, A.A. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47495 (INIS-SU–107/A, pp. 197) **Vanadium complexing with thiooxalates.** Kalinichenko, N.B. (AN SSSR, Moscow (USSR). Inst. Geokhimii i Analiticheskoj Khimii); Belyaeva, V.K.; Kordonskij, L.Eh.; Marov, I.N. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47496 (INIS-SU–107/A, pp. 218) **NMR study of addition products of metal alkoxides with low-coordinated phosphorus compounds.** Brusilovets, A.I. (Kievskij Gosudarstvennyj Univ., Kiev (Ukrainian SSR)). AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
'Short Communication.'

47497 (INIS-SU–107/A, pp. 200) **ESR study of fast solvate-exchange reactions in oxovanadium (4) β-diketonate solutions.** Veselov, I.A. (Kazanskij Gosudarstvennyj Univ., Kazan (USSR)); Shtyrlin, V.G.; Zakharov, A.V. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47498 (INIS-SU–107/A, pp. 201) **Investigation of processes of $NbCl_5$ complexing with β-diketones.** Zub, V.N. (AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii); Bublik, Zh.N.; Mazurenko, E.A.; Volkov, S.V. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47499 (INIS-SU–107/A, pp. 212) **ESR study of platinum metal complexing in alkaline medium.** Sidorov, A.A. (Moskovskij Inst. Tonkoj Khimicheskoj Tekhnologii, Moscow (USSR)); Miroshnichenko, I.V.; Moskovkin, A.S. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47500 (INIS-SU–107/A, pp. 216) **ODMR study of excited tripmultiplet states of Gd(3) complexes.** Sujsalu, A. (AN Ehstonskoj SSR, Tallin (USSR)); Zakharov, V.N.; Kamyshnyj, A.L.; Aslanov, L.A. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47501 (INIS-SU–107/A, pp. 230) **^{81}Br, ^{127}I NQR study of $AgBrO_3$, $AgIO_3$, Ag_2HgI_4.** Boguslavskij, A.A. (Kolomenskij Pedagogicheskij Inst., Kolomna (USSR)); Logfullin, R.Sh.; Svetlov, V.D. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47502 (INIS-SU–107/A, pp. 231) **$^{79,81}Br$, ^{127}I NQR study of Tl-containing inorganic compounds.** Boguslavskij, L.A. (Uzhgorodskij Gosudarstvennyj Univ., Uzhgorod (Ukrainian SSR)); Lotfullin, R.Sh. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47503 (INIS-SU–107/A, pp. 232) **NMR, XES, and IR-spectroscopy study of complexing ability of phosphorus-containing ionites.** Radionov, B.K.; Molochnikov, L.S.; Mudrakovskij, I.L.; Noskova, M.P. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47504 (INIS-SU–107/A, pp. 245) **Absorption spectra of rare earth diphthalocyanines in the near IR region.** Tomilova, L.G. (Nauchno-Issledovatel'skij Inst. Organicheskikh Poluproduktov i Krasitelej, Moscow (USSR)); Chernykh, E.V.; Ovchinnikova, N.A.; Bezlepko, Eh.V.; Mizin, V.M.; Luk'yanets, E.A. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47505 (INIS-SU–107/A, pp. 258) **Use of IR spectroscopy for determination of the structure of mixed-ligand lanthanide complexes with organic phosphorus compounds.** Slavetskaya, A.I. (Leningradskij Tekhnologicheskij Inst., Leningrad (USSR)); Afonin, M.A.; Mikhlin, E.B.; Belousov, E.A. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47506 (INIS-SU–107/A, pp. 259) **Spectroscopic study of hydrophobic interactions in coordination compounds with ligands modified by surfactants.** Chernova, R.K. (Saratovskij Gosudarstvennyj Univ., Saratov (USSR)); Shtykov, S.N.; Sorokin, N.N.; Smirnova, T.D. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47507 (INIS-SU–107/A, pp. 263) **Laser spectroscopy of rare earth (3) ion complexes with inorganic anions in nonaqueous solutions.** Svetashev, A.G. (Nauchno-Issledovatel'skij Inst. Prikladnykh Fizicheskikh Problem, Minsk (Byelorussian SSR)); Tsvirko, M.P. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN

SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413--: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47508 (INIS-SU–107/A, pp. 266) **Spectrochemical study of adducts of rare earth fluorinated β-diketonates.** Khomenko, V.S. (AN Belorusskoj SSR, Minsk (Byelorussian SSR). Inst. Fiziki); Pavich, T.A.; Lozinskij, M.O.; Fialkov, Yu.A. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413--: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47509 (INIS-SU–107/A, pp. 268) **X-ray photoelectron spectra and luminescence of europium (3) anthranilates.** Karasev, V.E. (AN SSSR, Vladivostok (USSR). Inst. Khimii); Kalinovskaya, I.V.; Mirochkin, A.G.; Nikolenko, Yu.M.; Ziatdinov, A.M. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413--: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47510 (INIS-SU–107/A, pp. 278) **NQR and diffuse reflection spectra of rhenium chalcochloride complexes.** Volkov, S.V. (AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Obshchej i Neorganicheskoj Khimii); Bryukhova, E.V.; Timoshchenko, N.I.; Kolesnichenko, V.L.; Kuznetsov, S.I. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413--: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47511 (INIS-SU–107/A, pp. 298) **Study of rhenium oxohalide coplex interaction with dithiol.** Borisova, L.V. (AN SSSR, Moscow (USSR). Inst. Geokhimii i Analiticheskoj Khimii); Prasolova, O.D.; Evtikova, G.A.; Marov, I.N. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413--: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47512 (INIS-SU–107/A, pp. 250) **^{79,81}Br NQR study of phase transition in $CsHg_2Br_5$.** Kirilenko, V.V. (AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii); Pakhomov, V.I.; Boguslavskij, A.A.; Lotfullin, R.Sh. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413--: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47513 (INIS-SU–107/A, pp. 251) **^{79,81}Br NQR study of the compounds in the system $CsBr-ZnBr_2$.** Boguslavskij, A.A. (Kolomenskij Pedagogicheskij Inst., Kolomna (USSR)); Lotfullin, R.Sh.; Kovaleva, I.S.; Kuznetsova, I.Ya.; Fedorov, V.I. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413--: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47514 (INIS-SU–107/A, pp. 264) **Application of moessbauer (^{119}Sn) and optical spectroscopy to study bimetallic platinum metal complexes with tin.** Antonov, P.G. (Leningradskij Tekhnologicheskij Inst., Leningrad (USSR)); Agashov, I.A.; Maksimov, M.N.; Emel'yanova, E.N.; Lutsko, T.P. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413--: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47515 (INIS-SU–107/A, pp. 272) **^{127}I NQR study of holmium iodide compounds with monovalent metals.** Dudareva, A.G. (Universitet Druzhby Narodov, Moscow (USSR)); Babushkina, T.A.; Volgin, K.Yu.; Nechitajlov, S.B. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413--: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47516 (INIS-SU–107/A, pp. 300) **Peculiarities of electron distribution during sequential reduction of complex ruthenium sulfates.** Maksimov, N.G. (AN SSSR, Krasnoyarsk. Inst. Khimii i Khimicheskoj Tekhnologii); Shpigunova, O.K. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413--: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds.*

Summaries of reports. Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47517 (INIS-SU–107/A, pp. 301) **Spectroscopic studies of cesium, strontium, and cerium (3) ion complexing with cobalt chlorinated dicarbollide (CCD) and hexapolyethylene glycol (HPEG) in nitrobenzene.** Afonin, M.A.; Kopyrin, A.A.; Korolev, V.V.; Dronova, T.V.; Lazarev, L.N.; Romanovskij, V.N. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47518 (INIS-SU–107/A, pp. 303) **Spectral characteristics and structure of coordination ethylxanthates of lanthanides.** Kup, V.S. (AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Fizicheskoj Khimii); Sevast'yanova, A.F. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47519 (INIS-SU–107/A, pp. 307) **Molybdenum (5) different-ligand complexes with 1,1,'- and 1,2-dithiols.** Trachevskij, V.V. (AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Kolloidnoj Khimii i Khimii Vody); Delemchuk, N.V.; Pilipenko, A.T. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47520 (INIS-SU–107/A, pp. 312) **Correlation studyj of the structure and spectroscopic characteristics of coordination compounds of double tungstates of alkali and rare earth elements.** Ksenofontova, N.M.; Lastochkina, V.A.; Puko, R.A.; Razvina, T.I. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47521 (INIS-SU–107/A, pp. 314) **Spectroscopic properties of heterovalent complexes of titanium, vanadium, iron, copper.** D'yachkova, T.A. (Kazanskij Gosudarstvennyj Univ., Kazan (USSR)); Galkina, S.A.; Kirillova, E.V.; Tarasov, O.Yu.; Glebov, A.N.; Sal'nikov, Yu.I. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47522 (INIS-SU–107/A, pp. 317) **Lanthanide shift reagent complexing with quaternary ammonium salts in low-polarity solvents in the presence of water.** Komarov, I.V. (Kievskij Gosudarstvennyj Univ., Kiev (Ukrainian SSR)); Turov, A.V.; Kornilov, M.Yu. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47523 (INIS-SU–107/A, pp. 318) **Different-ligand complexes of some d-metals with monovacant heteropolyanions.** Pilipenko, A.T. (AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Kolloidnoj Khimii i Khimii Vody); Trokhimenko, O.M.; Trachevskij, V.V. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47524 (INIS-SU–107/A, pp. 304) **Application of XPS, UV- and IR-spectroscopy to structure study of V(5) complexes in surface phase at $SiO_2/VO_{2.5}$ interface and catalysts on their basis.** Minyaev, A.I. (Leningradskij Tekhnologicheskij Inst., Leningrad (USSR)); Denisov, I.A.; Soroko, V.E. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47525 (INIS-SU–107/A, pp. 306) **Study of dynamic processes during phase transition in $ATiF_6$ center dot $6D_2O$ crystals.** Zeer, Eh.P. (AN SSSR, Krasnoyarsk (USSR). Inst. Fiziki); Falaleev, O.V.; Petrakovskaya, Eh.A.; Afanas'ev, M.L. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
Short Communication

47526 Prediction of shear viscosity and non-Newtonian behavior in the soft-sphere liquid. Hanley, H.J.M. (National Institute of Standards and Technology, Boulder, CO (USA)); Rainwater, J.C.; Huber, M.L. *International Journal of Thermophysics (USA),* 9(6): 1041-1050 (Nov 1988). (CONF-880606--: 10. symposium on thermophysical properties, Gaithersburg, MD (USA), 20-23 Jun 1988).

The authors show that a shear rate-dependent viscosity coefficient, normal pressure differences, and shear dilatancy can be predicted in a soft-sphere liquid given only the equilibrium radial distribution function and a relaxation time. Calculations are made using the relaxation-time theory of Hess and Hanley, and the results are compared with simulation data from nonequilibrium molecular dynamics.

47527 Pressure-induced spin-state interconversion of (Fe(6-Me-py)$_3$tren)(ClO$_4$)$_2$ in solution. Hammack, W.S. (Univ. of Illinois, Urbana (USA)); Conti, A.J.; Hendrickson, D.N.; Drickamer, H.G. *Journal of the American Chemical Society (USA),* 111(5): 1738-1741 (1 Mar 1989). DOE Contract AC02-76ER01198.

The series of pseudooctahedral Fe^{II} spin-crossover complexes (Fe(6-Me-py)$_3$tren)(ClO$_4$)$_2$ (4), (Fe(6-Me-py)$_2$pytren)(ClO$_4$)$_2$ (3), and (Fe(6-Me-py)py$_2$tren)(ClO$_4$)$_2$ (2) exhibit varying degrees of high- and low-spin population in solution. Specifically complex 4 is mostly high spin, while complexes 2 and 3 are of an intermediate spin state. The principal result of this paper is that with pressure the spin state of complex 4 changes from high spin ($^5T_2$) to low spin ($^1A_1$). This change is monitored by following the changes with pressure in the metal-to-ligand charge-transfer bands of the complex which are at higher energy and low intensity for a high-spin as compared to a low-spin complex. The effect of pressure on the metal-to-ligand charge-transfer (CT) bands of complexes 2, 3, and 4 has been studied in acetone and dichloromethane solutions. The pressure range studied is from 0.001 kbar to 10.0 kbar (1.0 kbar = 986.92 atm = 0.1 GPa). The predominant effect of pressure, in both media for all three complexes, is a shift to lower energy and an increase in intensity of the CT bands. The difference in magnitude for these spectral changes with pressure indicate that the predominantly high-spin complex 4 is converted to a low-spin complex in solution upon the application of pressure.

47528 Polymerization and decarbonylation reactions of aldehydes on the Pd(111) surface. Davis, J.L. (Univ. of Delaware, Newark (USA)); Barteau, M.A. *Journal of the American Chemical Society (USA),* 111(5): 1782-1792 (1 Mar 1989). DOE Contract FG02-84ER13290.

The adsorption and reaction of formaldehyde, acetaldehyde, and propanal were compared in temperature-programmed desorption (TPD) and high-resolution electron energy loss spectroscopy (HREELS) studies on a clean Pd(111) surface. Formaldehyde reacted upon adsorption at 170 K via decomposition to CO(a) and H(a) and polymerization to paraformaldehyde. In contrast, decomposition of the higher aldehydes required significantly higher temperatures. Acetaldehyde adsorbed on the clean surface in an η^2 configuration and reacted to form stable acetyl species ($CH_3C{=}O$), which decomposed above 300 K to produce CO(a), H(a), and C_1 hydrocarbon fragments. Adsorbed acetyl groups were readily identified by the characteristic frequency of their CO stretch at 1565 cm^{-1}. In competition with decarbonylation, desorption of acetaldehyde occurred at 220 and 325 K. The CO stretch of η^2-acetaldehyde was observed at 1390 cm^{-1}. Similarly, the adlayer produced by the adsorption of propanal on Pd(111) was a mixture of η^2-propanal and propanoyl species ($CH_3CH_2C{=}O$) produced by removal of the aldehyde hydrogen atom. No evidence was found for polymerization of either acetaldehyde or propanal on the clean Pd(111) surface. A kinetic isotope effect was observed in the decomposition of adsorbed acetyl intermediates, suggesting that C-H cleavage is rate determining for this reaction. These results illustrate the pathways, intermediates, and energetics of aldehyde decarbonylation reactions on group VIII metal surfaces and may provide insights into the mechanism of oxygenate synthesis from CO and H_2.

47529 Inclusion tuning of nonlinear optical materials: Sorbates in the KTP structure. Eddy, M.M. (Univ. of California, Santa Barbara (USA)); Gier, T.E.; Keder, N.L.; Stucky, G.D.; Cox, D.E.; Bierlein, J.D.; Jones, G. *Inorganic Chemistry (USA),* 27(11): 1856-1858 (1 Jun 1988). DOE Contract AC02-76CH00016.

Potassium titanyl phosphate, KTiOPO$_4$ (KTP), has been reported to be a premium material used for second harmonic generation (SHG) of the 1.06 μm YAG laser. Large crystals of the ammonium analog of KTP, $(NH_4)_2(TiOPO_4)_2$ (NTP), has been synthesized by hydrothermal techniques. Selective deammoniation of NTP to $NH_4H(TiOPO_4)_2$ (NHTP) was achieved under vacuum at 10^{-5} mm at 223°C, and the second ammonia molecule is lost above 250°C to yield $H_2(TiOPO_4)_2$. SHG measurements on the original NTP and NHTP showed signals 2400 and 40 times that of quartz. The structure/electrooptic relationship that defines the tuning of the SHG signal in NTP, NHTP, and samples of NHTP that had been rehydrated was studied by single-crystal and high-resolution x-ray synchrotron powder diffraction techniques. 16 references, 2 figures, 1 table.

47530 Temperature-dependent enantiospecificity of secondary alcohol dehydrogenase from Thermoanaerobacter ethanolicus. Pham, V.T. (Univ. of Georgia, Athens (USA)); Phillips, R.S.; Ljungdahl, L.G. *Journal of the American Chemical Society (USA),* 111(5): 1935-1936 (1 Mar 1989). DOE Contract FG09-86ER13614.

An alcohol dehydrogenase reported from Thermoanaerobium brockii catalyzes the asymmetric reduction of aliphatic acyclic ketones. An interesting substrate size-induced reversal of stereoselectivity at 37°C was observed by Keinan and co-workers in their studies of this latter enzyme. The smaller substrates (2-butanone, 3-methyl-2-butanone, or methyl cyclopropyl ketone) were reduced to (R)-alcohols, whereas 2-pentanone and the longer chain ketones provided the (S)-alcohols. In order to evaluate the mechanistic basis of this unusual stereochemical reversal, the authors have studied the kinetics of the reaction of SADH from T. ethanolicus with the (R)- and (S)-enantiomers of the simple secondary alcohols, 2-butanol and 2-pentanol.

47531 Utility of cyclodichlorophosphazene as a NaC_5H_5 scavenging reagent: Synthesis of an organoyttrium hydroxide complex and the x-ray crystal structure of the layered compound ($(C_5H_5)_2Y(\mu\text{-}OH)$)$_2$ ($C_6H_5C{\equiv}CC_6H_5$). Evans, W.J. (Univ. of California, Irvine (USA)); Hozbor, M.A.; Bott, S.G.; Robinson, G.H.; Atwood, J.L. *Inorganic Chemistry (USA),* 27(11): 1990-1993 (1 Jun 1988).

$(C_5H_5)_3Y(THF)$ reacts with NaOH in THF to form NaC_5H_5 and $(C_5H_5)_2Y(OH)(THF)$. Treatment of the mixture of solids from this reaction with an 80%:20% mixture of $(NPCl_2)_3$ and $(NPCl_2)_4$ in toluene allows the separation of the hydroxide complex by filtration. $((C_5H_5)_2Y(\mu\text{-}OH))_2$, formed by partial hydrolysis of a $(C_5H_5)_2Y(t\text{-}C_4H_9)(THF)/C_6H_5C{\equiv}CC_6H_5$ mixture, crystallizes from a 1:2 mixture of THF/hexane in the presence of $C_6H_5C{\equiv}CC_6H_5$ in space group $P2_1/c$ with unit cell dimensions a = 9.346 (7) Å, b = 21.284 (8) Å, c = 8.262 (5) Å, β = 112.50 (3)°, and Z = 2 for D_{calcd} = 1.43 g cm^{-3}. Least-squares refinement on the basis of 513 observed reflections converged to a final R = 0.068. The molecular structure consists of two $(C_5H_5)_2Y$ units bridged by OH groups with Y-O distances of 2.33 (2) and 2.36 (2) Å. The $C_6H_5C{\equiv}CC_6H_5$ molecules occupy alternate layers between layers of the hydroxide molecules. The layers are oriented such that the hydroxide ligands are oriented toward the C≡C bonds of the diphenylethyne molecules. 31 references, 2 figures, 4 tables.

47532 Unusually rapid homolysis of the cobalt-carbon bond in a macrocyclic benzylcobalt complex. Bakac, A. (Iowa State Univ., Ames (USA)); Espenson, J.H. *Inorganic Chemistry (USA),* 26(26): 4305-4307 (30 Dec 1987). DOE Contract W-7405-ENG-82.

The preparation of a benzylcobalt complex of a synthetic macrocycle, $C_6H_5CH_2Co((14)aneN_4)(H_2O)^{2+}$, where ((14)aneN$_4$) is 1,4,8,11-tetraazacyclotetradecane is reported. This compound was found to homolyze in aqueous solutions even more rapidly than benzylcobalamin. It is proposed that a substantial contribution to the ease of the homolysis of the C-C bond in the prepared compound comes from the large positive value of $\Delta S^{\ddagger}$ for the compound. These authors attribute this large value of $\Delta S^{\ddagger}$ to the influence of the overall 2$^+$ charge on the change in solvation of the benzyl group between the ground and transition states. 16 references, 1 table.

47533 Preparation, properties, and crystal structure of a novel series of macrocyclic organocobalt complexes. Bakac, A.

(Iowa State Univ., Ames (USA)); Espenson, J.H. *Inorganic Chemistry (USA),* 26(26): 4353-4355 (30 Dec 1987). DOE Contract W-7405-ENG-82.

The organocobalt complexes $((H_2O)((14)aneN_4)CoR)(ClO_4)_2$ (R = primary alkyl, substituted primary alkyl, and benzyl; (14)aneN$_4$ = 1,4,8,11-tetraazacyclotetradecane) were prepared photochemically from the corresponding alkylcobaloximes and the cobalt(II) macrocycle. The complexes were characterized by elemental analysis, ^{1}H NMR spectroscopy, a crystal structure determination for R = ethyl, and uv-visible spectroscopy. The ethyl complex, $((H_2O)((14)aneN_4)CoC_2H_5)(ClO_4)_2 \times H_2O$, crystallizes in the monoclinic crystal system, space group $P2_1/n$, with four molecules in a unit cell of dimensions a = 8.901 (11) Å, b = 12.254 (21) Å, c = 19.637 (15) Å and β = 91.76 (22)°. The data refined to a final value of the weighted R factor of 0.083 based on 1242 independent observations. The complex is hexacoordinated, with the ethyl group and a coordinated molecule of water as axial ligands. All of the complexes are photosensitive and readily decompose to cobalt(II) and carbon-centered radicals when irradiated with visible light. Air-stable acidic aqueous solutions of the alkyl complexes show no sign of decomposition in hours when kept in the dark. The hydroxymethyl complex, prepared by a modified Fenton reaction, is air-sensitive, and the benzyl complex undergoes rapid homolysis of the cobalt-carbon bond. 31 references, 1 figure, 5 tables.

4004 Electrochemistry

Refer also to citation(s) 47017

47534 (ORNL/FTR–3288) **[The theory of ac impedance of rough electrode-electrolyte interfaces]: Foreign trip report, May 19, 1989–June 5, 1989.** Liu, S.H. Oak Ridge National Lab., TN (USA). 19 Jun 1989. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017474/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The author attended the First International Symposium on Electrochemical Impedance Spectroscopy and presented an invited lecture on the theory of ac impedance of rough electrode-electrolyte interfaces. After the symposium the author spent four days at Ecole Polytechnique, Palaiseau, on the outskirt of Paris to give an invited talk and to discuss the application of fractal concepts to a number of problems related to the physical properties of electrochemical systems.

47535 Chemical phenomena in solid-state voltammetry in polymer solvents. Geng, L. (Univ. of North Carolina, Chapel Hill (USA)); Reed, R.A.; Kim, M.H.; Wooster, T.T.; Oliver, B.N.; Egekeze, J.; Kennedy, R.T.; Jorgenson, J.W.; Parcher, J.F.; Murray, R.W. *Journal of the American Chemical Society (USA),* 111(5): 1614-1619 (1 Mar 1989). DOE Contract FG05-87ER13675.

This paper, aimed at delineating significant chemical effects in solid-state voltammetry, describes electrochemical oxidations and reductions of electroactive monomer solutes dissolved in and diffusing through rigid and semirigid polymer electrolyte solvents. Sorption of organic monomer vapors into poly(ethylene oxide) films yields polymer solvents whose chemistry is dominated by that of the sorbed monomer as shown by coordination and precipitation effects. The dynamics of plasticization-induced changes in transport rates are quite rapid. Physical diffusion in the polymer solvent in slow enough that electron hopping reactions measurably enhance charge transport rates; the effect was used to estimate a lower limit for the $(Co(bpy)_3)^{2+/+}$ self-exchange rate constant of 2×10^9 M^{-1} s^{-1}. It is possible to erect polymeric film transport barriers at the electrode/polymer solvent interface and to measure the rate of permeation of monomer complexes from the polymer solvent into the polymer transport barrier film. Polymeric films of Os and Ru polypyridine complexes can be electropolymerized from polymer solutions of the corresponding monomers. Solid-state voltammetry can be extended to other polymer solvents including sulfonated polystyrene, poly(vinyl chloride), Nafion, and poly(acrylamide) gel.

4005 Photochemistry

Refer also to citation(s) 47022, 47483, 47920

47536 An HTP kinetics study of the reaction of O(^{3}P) atoms with propylene over the 300 to 1215 K temperature range. Mahmud, K. (Rensselaer Polytechnic Institute, Troy, NY (USA)); Fontijn, A. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). DOE Contract FG02-84ER13224. From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The O + C_3H_6 reaction has been studied in a high-temperature photochemistry (HTP) reactor under pseudo-first order conditions, [O] << [C_3H_6], at temperatures from 300 to 1215 K and pressures from 90 to 610 torr. Ground state O atoms were generated by flash-photolysis of O_2 or CO_2. The data are well fitted by the empirical expression $k(T) = 2.6 \times 1\text{-}^{-16}$ $(T/K)^{1.6}$ exp (316 K/T) cm^3 molecule^{-1} s^{-1}, with an estimated confidence limit of +/- 25%. The results are consistent with transition-state theory calculations assuming O-atom addition to the double bond as the rate-controlling step over the entire temperature range.

47537 Primary products of the reaction between O(^{3}P)-atoms and C_2H_4 studied with ESR- and LMR-detection. Bley, U. (Max-Planck-Institut fuer Stroemungsforschung, Goettingen (West Germany)); Dransfeld, P.; Himme, B.; Koch, M.; Temps, F.; Wagner, H.G. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The primary products of the reaction between O(^{3}P)-atoms and C_2H_4 have been studied at room temperature in the gas phase. The products in the low pressure regime were investigated in two isothermal discharge flow systems with Electron Spin Resonance (ESR) detection of O- and H-atoms and Far Infrared Laser Magnetic Resonance (LMR) detection of O-atoms and HCO- as well as CH_2-radicals. The absolute concentrations of these species were determined using several independent titration reactions. The formation of the high pressure stabilization products ethylene oxide and acetaldehyde was observed in a static system at pressures between 5 bar { <=} p { <=} 70 bar using Hg-sensitized decomposition of N_2O as the O-atom source and gas chromatographic analysis. From the half pressure for CH_3CHO production the lifetime of the addition complex from O + C_2H_4 with respect to redissociation and dissociation into fragments is concluded to be of the order 10^{-11} s. Thus, 1.2 H-atom migration in the addition complex has to proceed on this time scale. 49 refs.

47538 Laser photolysis shock tube for combustion kinetics studies. Davidson, D.F. (Stanford Univ., CA (USA)); Chang, A.Y.; Hanson, R.K. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

An excimer laser photolysis method has been developed for shock tube kinetics studies of elementary combustion reactions. The excimer laser provides a high intensity source of UV photons well suited to the rapid production of reactive radicals, while shock wave heating provides a convenient means of varying the reaction environment over a wide temperature range. An ArF excimer (193.3 nm) was used to photolyze H_2O behind reflected shock waves to produce H and OH radicals. The temporal variation of the OH concentration was monitored using a cw, narrow-linewidth laser absorption diagnostic, and the rate coefficient of the dominant reaction after photolysis, H + H_2O → OH + H_2, was determined. The measured rate coefficient, $k = 2.4(\pm.25) \times 10^{14}$ exp (-10750 ±500/T,K) cm^3 mole^{-1}s^{-1}, T = 1600 - 2500 K, is in good agreement with other recent studies of this reaction in both the forward and reverse directions.

47539 (DOE/ER/13592–4) **Photoexcited charge pair escape and recombination: Progress report, August 1, 1988–August 1, 1989.** Braun, C.L. Dartmouth Coll., Hanover, NH (USA). Dept. of Chemistry. Aug 1989. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER13592. Order Number DE89017637/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We have studied the escape and recombination of charge pairs produced by photoexcitation of organic molecules. This work has been directed toward the understanding of two separate but related

problems: (1) What is the best (quantitative) description of the geminate charge pairs produced by photoionization of solute molecules in a low dielectric constant liquid like hexane? (2) What quantitative model describes charge pair dissociation in electron-donor-acceptor (EDA) solids in which the lowest energy excited states have charge-transfer (CT) character? Both areas involve charge pair dissociation and recombination in organic molecular materials, but they differ in that liquids like hexane are very poor electron acceptors. The photoionization of durene in hexane, as well as an absorption spectrum of the triplet state of anthracene in hexane, is discussed. Other topics included dissociation of charge transfer states in organic donor-acceptor solids, and time-resolved photoconductivity in the phenanthrene-PMDA CT complex. 2 figs.

47540 Cadmium sulfide mediated photoelectric effects in bilayer lipid membranes. Baral, S. (Syracuse Univ., NY (USA)); Fendler, J.H. *Journal of the American Chemical Society (USA),* 111(5): 1604-1614 (1 Mar 1989).

Development of semiconductor- and magnetic-particle-containing bilayer lipid membranes (BLMs) has been prompted by the mimetic relevance of these systems. In particular, the authors have been interested for some times in artificial photosynthesis. Optimization of a given system requires an understanding of the mechanisms of photoelectron transfers in the environments of, and across, mimetic membranes. They have undertaken, therefore, a systematic study of semiconductor-mediated photoelectric effects in BLMs. The present article reports results on steady-state and time-resolved, cadmium sulfide mediated photovoltage and photocurrent measurements in glyceryl monooleate BLMs.

47541 Flash photolysis studies of RhCl(CO)L2 (L = trimethyl- or tritolylphosphine). Evidence for intermediates in the photocatalytic carbonylation of hydrocarbons. Spillett, C.T. (Univ. of California, Santa Barbara (USA)); Ford, P.C. *Journal of the American Chemical Society (USA),* 111(5): 1932-1933 (1 Mar 1989). DOE Contract FG03-85ER13317.

Recently, Kunin and Eisenberg then Tanaka and others have reported that various trans-$RhCl(CO)L_2$ (L = a trialkyl- or triarylphosphine) serve as photocatalysts for carbonylation and other C-H activation pathways of certain hydrocarbons (e.g., eq 1). Of these the trialkylphosphine complexes have been shown Ph-H + CO $\xrightarrow{h\nu}{}_{RhCl(CO)L_2}$ Ph-CHO to be effective even for alkane activation. Herein are reported results of the flash photolysis investigation of two representative complexes, trans-$RhCl(CO)(PMe_3)_2$ (I) and trans-$RhCl(CO)\text{-}(P(tolyl)_3)_2$ (II, tolyl = p-$CH_3C_6H_4$-).

4006 Radiation Chemistry

Refer also to citation(s) 47439

47542 (INIS-SU–107/A, pp. 202) **Application of ESR technique and low-temperature radiation chemistry to determine the number of water molecules in a hydrate shell of dissolved substance.** Parfent'ev, V.A. (Kazakhskij Gosudarstvennyj Univ., Alma-Ata (USSR)); Muratbekov, M.B. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.

Short Communication

47543 (N–89-21103) **Degradation and crosslinking of perfluoroalkyl polyethers under X-ray irradiation in ultrahigh vacuum.** Mori, S.; Morales, W. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Mar 1989. 15p. (NASA-TP–2910;E–4500;NAS–1.60:2910). Available from NTIS, PC A03/MF A01.

Degradation of three types of commercially available perfluoroalkyl polyethers (PFPE)-Demnum S200, Fomblin Z25, and Krytox 16256-by X-ray irradiation was studied by using X-ray photoemission spectroscopy (XPS) and a mass spectrometer under ultra-high-vacuum conditions. The carbons in the polymers were characterized by chemical shifts of Cls binding energies. Gaseous products containing COF2 and low-molecular-weight fluorocarbons were formed. From Fomblin Z25, which has acetal linkages (-OCF2O-), a large quantity of COF2 gas was evolved. Liquid products became tacky after a long irradiation time, and some did not dissolve in Freon. High-pressure liquid chromatography (HPLC) showed that molecular weight distribution became broader and that higher molecular weight polymers were formed from Demnum and Krytox. We concluded from these results that degradation and cross-linking took place simultaneously. Demnum crosslinked more easily than the other fluids. The time dependence of both XPS spectra of Cls and mass spectra showed that C-O-bonded carbons in PFPE'S were removed faster than other carbons. There was no substrate effect on the degradation reaction because the first-order rate constants calculated from the change of gaseous products were similar when stainless steel (440C) and gold-coated surfaces were used. Metal fluorides were formed on stainless steel during the reaction. A mechanism for the degradation of PFPE'S is discussed on the basis of their molecular structures.

47544 Radiation chemistry: Little known branch of science. Markovic, V. (International Atomic Energy Agency, Vienna (Austria). Dept. of Research and Isotopes). *International Atomic Energy Agency Bulletin (IAEA),* 31(1): 20-23 (1989).

Radiation chemistry is a branch of chemistry (some say physical chemistry) that studies chemical transformations in materials exposed to high-energy radiations. It uses radiation as the initiator of chemical reactions, as a source of energy that disrupts the sensitive energy balance in stable systems. In that way it is a younger sister of photochemistry, which does the same, but uses another type of electromagnetic energy - light - as the initiator. Radiation chemistry does not deal with radioactive elements (as radiochemistry does), except to use them as a source of radiation, always physically separated from the irradiated system. Practical applications of radiation chemistry today extend to many fields, including health care, food and agriculture, manufacturing, and telecommunications.

4007 Radiochemistry and Nuclear Chemistry

Refer also to citation(s) 48085

47545 (CEA-TR–2373) **Preparation of radioactive labelled compounds Pt.1. ^{82}Br labelled organic bromine compounds.** Otto, R. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). May 1988. 11p. (In French). Order Number DE90701458/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

A simple method allowing the preparation of ^{82}Br labelled organic bromine compounds from olefins with chemical and radiochemical yields between 75 and 95% and the specific activities required, is described.

47546 (CEA-TR–2374) **Preparation of radioactive labelled compounds. Pt. 2. ^{82}Br labelled organic bromine compounds by isotopic exchange.** Otto, R. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). May 1988. 12p. (In French). Order Number DE90701457/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

Studies on isotopic exchange between organic bromine compounds and ^{82}Br labelled dioxane dibromide in the presence of $AlCl_3$ are described. The results obtained enable to develop a simple and quick preparation method for the labelling with ^{82}Br.

47547 (INIS-BR–1589) **Contribution to the study of the chemical effects of the (n, γ) reaction on copper N-benzoyl N-phenyl hydroxylaminate and copper N-benzoyl N-(o) Tolyl hydroxylaminate.** Nakanishi, C. Instituto de Pesquisas Energeticas e Nucleares, Sao Paulo, SP (Brazil). 1987. 97p. (In Portuguese). Order Number DE90601153/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

The influence of some factors such as pre-heating and pre-irradiation with gamma rays on the retention and thermal annealing

of copper N-benzoyl N-phenyl hydroxylaminate and of copper N-benzolyl N-(o) tolyl hydroxylaminate is studied. The complexes were synthesized and characterized by determination of the melting-point, elemental analysis, X-ray diffraction, infra-red and visible range absoption spectrometry-thermogravimetric analysis were examined and the stability of the compounds was checked against heating and gamma irradiation from a ^{60}Co source. Some experiments using the Szilard-Chalmers effect were carried out by irradiating the compound in the IEA-R_1 nuclear reactor and calculating its specific activities. (M.J.C.).

47548 (INIS-mf–11999) **Studies of the conversion-chemistry of plutonium and uranium in the nitrate- and carbonate-systems. Final report.** Hoffmann, G.; Steinhauser, M.; Boehm, M. Muenchen Univ. (Germany, F.R.). Inst. fuer Anorganische Chemie; Bundesministerium fuer Forschung und Technologie, Bonn (Germany, F.R.). [1988]. 40p. (In German). Contract BMFT 02U5635. Order Number DE90702746/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

A novel type construction of an autoclave for dissolving of plutonium dioxide in concentrated nitric acid (without any admixtures) has been developed. This process allows the dissolving of batches with high oxide/acid ratio and yields plutonium-solutions of high concentration. The tests for separation of plutonium- and, respectively, uranium-process-solutions from Am-241 and other interfering impurities are described. The time-factor for the oxidation-reaction of plutonium in nitric acid with ozone has been optimized. Important data on the solubility-behavior of plutonyl(VI)- and of pure Pu(IV)-nitrates have been gained. The majority of the precipitates, occuring in theses reactions, were characterized. (orig.).

47549 (INIS-SU–107/A, pp. 146) **^{1}H, ^{19}F, NMR study of crystal dynamics of ammonium and rubidium pentafluorouranylates.** Kavun, V.Ya. (AN SSSR, Vladivostok (USSR). Inst. Khimii); Sergienko, V.I. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.

Short Communication

47550 (INIS-SU–107/A, pp. 233) **Crystal structure and spectroscopic properties of tetraphenylarsonium tetrachlorouranylate.** Andreeva, S.G. (Kievskij Gosudarstvennyj Univ., Kiev (Ukrainian SSR)); Ivanova, E.I.; Kravers, M.A.; Kushnirenko, I.Ya. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.

Short Communication

47551 (INIS-SU–107/A, pp. 293) **Spectroscopic study of U(5) coordination compounds.** Kobets, L.V. (Nauchno-Issledovatel'skij Inst. Prikladnykh Problem, Minsk (Byelorussian SSR)); Bend', N.G.; Ksenofontova, N.M. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.

Short Communication

47552 (INIS-SU–107/A, pp. 295) **Electron spectroscopy of the gas phase of uranium (6) alkoxides.** Krasnodubskaya, S.V. (AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii); Sevast'yanov, V.G.; Kuznetsov, N.T. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.

Short Communication

47553 (JAERI–1315) **Studies on rapid ion-exchange separation of the transplutonium elements with mineral acid-methanol mixed media.** Usuda, Shigekazu. Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1989. 102p. Order Number DE90701676/JAW. Available from NTIS (US Sales Only), PC A06/MF A01.

In order to study properties of short-lived transplutonium nuclides synthesized by heavy-ion bombardment, three methods for rapid separation of tri-valent transplutonium elements by ion-exchange chromatography with mineral acid-methanol mixed media at elevated temperature were investigated. The first separation method was anion-exchange chromatography with nitric acid-methanol mixed media. The second method was anion-exchange choromatography with dilute hydrochloric acid-methanol mixed media. The third method was improved cation-exchange chromatography with single-column operation using the mixed media of hydrochloric acid and methanol. The separation methods developed were found applicable to studies on synthesis of the trans-plutonium nuclides, ^{250}Fm ($T_{1/2}$:30 min), $^{244,245,246}Cf$ ($T_{1/2}$:20 min, 46 min and 35.7 h, respectively) from the $^{16}O + ^{238}U$ and $^{12}C + ^{242}Pu$ reactions, and on the decay property of ^{245}Cf. Attempts to search for new actinide nuclides, such as ^{240}U and neutron deficient nuclides of Am, Cm and Bk, were made by a quick purification. The separation system was also applied to the rapid and effective separation of Nd, Am and Cm from spent nuclear fuel samples, for burn-up determination. (J.P.N.) 242 refs.

47554 (UM-P–88/115) **Calcium uranium titanate - a new pyrochlore.** Dickson, F.J.; Hawkins, K.D.; White, T.J. Melbourne Univ., Parkville (Australia). School of Physics. 1988. 12p. Order Number DE90601258/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

A calcium uranium dititanate pyrochlore ($A_2B_2O_7$), as a component of a high level nuclear waste ceramic, was characterized by powder X-ray diffraction, analytical electron microscopy and selected area electron diffraction. The cubic unit cell (a $10.1579(5)\times10^{-10}$ m) has symmetry Fd3m with A in 16(c), B in 16(d), O in 48(f) and O_2 in 8(a). A preliminary examination of the peak intensity in X-ray powder patterns and chemical analyses by energy dispersive X-ray spectroscopy suggests that although this pyrochlore may be approximately described by the crystallochemical formula $[Ca,U][Ti_2]O_7$ it is likely that the Ca/U ratio deviates from unity.

47555 **Ultrapure materials for alpha particle-sensitive applications.** Dunlop, J.A. (Johnson Matthey Electronics (US)); Ritala, K.E.; Gibbard, J.R.; Beauprie, R.; Pouliquen, B.; Reeves, J.H.; Huneke, J.C.; Vieth, W.A. *Journal of Metals (USA)*, 41(6): 18-21 (Jun 1989).

Materials used in applications where alpha particle radiation can produce soft or transitory errors are commonly specified and characterized in terms of uranium and thorium content, often by glow discharge mass spectrographic analysis. Analytical results indicate that low levels of uranium and thorium do not adequately reflect the alpha flux potential of some materials, especially in cases where radioactive isotopes are not in equilibrium or where a dominant decay

parent other than uranium or thorium is present. An additional characterization technique - highly sensitive, surface alpha particle flux measurement - has been developed. Alpha particle counting, when used in conjunction with trace metal analysis, allows more optimum selection of low-alpha-radiation materials.

47556 Oxygen-17 NMR of seven-valent neptunium in aqueous solution. Appelman, E.H. (Argonne National Lab., IL (USA)); Kostka, A.G.; Sullivan, J.C. *Inorganic Chemistry (USA)*, 27(11): 2002-2005 (1 Jun 1988). DOE Contract W-31-109-ENG-38.

Alkaline solutions of seven-valent neptunium in water enriched in oxygen-17 show a ^{17}O NMR resonance about 1470 ppM downfield from the solvent resonance. Measurement of relative areas indicates that the Np(VII) oxygen resonance contains about four oxygen atoms per Np atom. This result is interpreted in terms of the six-coordinated Np(VII) anion $NpO_4(OH)_2^{3-}$, in which four oxygen atoms are present in a square plane around the Np and are responsible for the observed resonance. The two hydroxyl groups are located further from the Np at the vertices of a tetragonal bipyramid and presumably exchange too rapidly with solvent oxygen for their ^{17}O resonance to be seen. The Np(VII) oxygen resonance has a line width that increases with temperature and is around 400 Hz at 25°C. The temperature dependence of the line width can be accounted for by a process of oxygen exchange between the Np(VII) species and the solvent, with a pseudo-first-order rate constant of about $10^3 s^{-1}$ at 25°C. No Np(VI) oxygen resonance was observed in alkaline solution, probably because the Np(VI) oxygens exchange too rapidly with the solvent. 21 references, 2 tables.

4008 Combustion, Pyrolysis, and High-temperature Chemistry

Refer also to citation(s) 46842, 46848, 46885, 46902, 46903, 46915, 46916, 46922, 47285, 47303, 47304, 47462, 47464, 47465, 47466, 47467, 47468, 47469, 47470, 47536, 47537, 47538, 47773, 47920

47557 Overall kinetic parameters for combustion of a highly non-spherical carbon char. Waters, B.J. (Purdue Univ., West Lafayette, IN (USA)); Mitchell, R.E.; Squires, R.G.; Laurendeau, N.M. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Overall kinetic parameters describing the combustion of an irregularly-shaped carbon char are obtained based on optical measurements of the temperature, size, and velocity of individual particles observed in an entrained-flow reactor. In addition, for one set of condition, the mass loss profile is measured by quantitatively collecting samples of partially burned char at four different heights in the reactor. The combustion condition investigated in this study range from 12 to 36 mole-% O_2 with bulk gas temperatures from 1400 to 1800 K, resulting in particle temperatures from 1400 to 2100 K and overall burning rates from 8.9×10^{-3} to 1.3×10^{-1} gC/s.cm^2 (based on the external surface of the particle). The kinetic parameters obtained from the temperature measurements are used to calculate the measured mass loss profile. Good agreement between the measured and calculated profiles is achieved when CO_2 formation near the particles is accounted for in the single-particle energy balance. Despite the uncertainty in the particle temperatures caused by the irregular shape of the particles, the kinetic parameters are relatively insensitive to the simplifying assumption of a spherical particle. The measurements support an apparent reaction order of 0.7 ± 0.2 and an apparent activation energy of 23 ± 2 kcal/mol.

47558 The evolution of porosity during the combustion of char: The fractal approach and the statistic description. Delfosse, L. (Universite des Sciences et Techniques de Lille, Villeneuve D'Ascq (France)); Ponsolle, L.; Jabkhiro, E.H. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The development of porosity during the combustion of char from poly(phenolformaldehyde) foam has been followed as a function of time by usual surface and pore partition evaluation techniques (B.E.T., B.J.H., mercury porosimetry and CO_2 adsorption). It was found that the specific surface area jumps dramatically as the material crosses its critical limit of incandescence. This increase in surface area is due to the development of an important microporosity. Using molecules of various cross section to perform the B.E.T. technique, it was shown that the surface became fractal during the course of combustion with a fractal dimension D equal to 2.9. The analysis of the micropore repartition curves shows that the results fit well the equation previously proposed by Pfeifer et al ($dV/d\rho \propto \rho^{2-D}$). It is concluded that the function proposed by Simons ($dV/d\rho \propto \rho^{-1}$) may be understood as a limiting case, valid for large values of D.

47559 Reaction order for low temperature oxidation of carbons. Suuberg, E.M. (Brown Univ., Providence, RI (USA)); Wojtowicz, M.; Calo, J.M. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). DOE Contract FG22-83PC60800. From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A detailed study of the reaction order and activation energy of O_2 gasification of chars has been carried out in this laboratory utilizing phenol-formaldehyde resin chars with low impurity levels. A survey of the literature on this topic suggests that the true order of reaction for low temperature oxidation of chars is fractional, with values in the range from 0.2 to 1 being observed in different studies. In this study, it was noted that there appears to be only a limited variation of reaction order (0.68 ± 0.08) with burnoff, char heat treatment temperature or oxidation temperature (the latter in the limited range from 573 to 673 K). The oxygen partial pressure range examined was 0.5 to 101 kPa. The reaction order for the oxygen chemisorption process, on the other hand, was essentially unity on these same materials. The activation energy for gasification, likewise, was relatively invariant with heat treatment temperature, despite an order of magnitude change in overall reactivity upon heat treatment.

47560 An integration path for the carbon-oxygen reaction with internal reaction. Essenhigh, R.H. (Ohio State Univ., Columbus (USA)). pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). DOE Contract AC22-84PC70815. From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

An analytical extension of the Thiele analysis for reaction in a porous particle relates the variation of density and diameter during reaction by the power index equation: $\sigma/\sigma_o = (d/d_o)^\alpha$. This provides specification of a path that permits integration of the inexact DE for combustion of a particle when there is also internal reaction. Reformulation of the particle rate equation along the σ-d path for a given α leads to a new Extended Resistance Equation (ERE) that combines the processes of boundary layer diffusion, adsorption, desorption, and internal diffusion. This is proposed as an alternative to the commonly used but empirical n-th order kinetic equation. The integration also introduces a second factor: $\epsilon = 1+\alpha/3$. This factor is shown to be a divisor for the experimental reaction rates to calculate intrinsic rates. Values of ϵ can be very sensitive to temperature. At flame temperatures the values are typically 2 or 3 and the diameter varies substantially with burn-off. At low temperatures, however, the values can be as high as 10^4 or 10^5 and the diameter is essentially constant through the whole of burn-out.

47561 Soot formation in combustion processes. Glassman, I. (Princeton Univ., NJ (USA)). pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Sooting tendencies of fuels are analyzed with respect to the type of experimental configuration used - pre-mixed flames, normal and inverse co-annular, Wolfhard-Parker and counter-flowing diffusion flames, or shock tubes. The important effect of temperature in each type of experiment is examined. The relative tendency of various fuels to soot when consumed in pre-mixed and diffusion flames has been determined by the qualitative measurements of critical sooting equivalence ratios and smoke heights at various temperatures and quantitatively confirmed by measurements of chemical species, soot number density and volume fraction. Fuel structure has a significant effect on the sooting tendency of diffusion flames, but little influence in pre-mixed flames. Irrespective of the fuel in diffusion flames soot inception occurs around 1400 K and is dependent somewhat on H

atom diffusion. Particle burnout ceases at about 1300 K and is responsible for the smoke height. Incipient particle formation determines the volume fraction of soot and is controlled by the rate of formation of the first aromatic species containing one to two rings. The particle growth process is found to be the same regardless of flame type. A generalized chemical mechanism of soot formation irrespective of flame type or process is presented. The various routes in this mechanism support the relative sooting tendency of fuels found in both flame and shock tube experiments. The effect of oxygen added to various fuel in diffusion controlled experiments is analyzed. 70 refs.

47562 Experimental and computational investigation of the structure of a sooting C_2H_2-O_2-Ar flame. Bastin, E. (C.R.C.C.H.T.-C.N.R.S., Orleans (France)); Delfau, J.L.; Reuillon, M.; Vovelle, C.; Warnatz, J. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Mole fraction profiles have been measured by molecular beam-mass spectrometer technique in a sooting C_2H_2-O_2-Ar flame (27.5%-27.5%-45%) stabilized under reduced pressure (2.6 kPa) on a flat flame burner. Emphasis was put on the detection and concentration measurement of the intermediate species which play a role in the formation of the first aromatic rings. In addition to the major products and the radicals usually involved in acetylene oxidation mechanisms, C_2H, C_2H_3, C_3, C_4 species and benzene have been measured. The mole fraction profiles have been compared with predictions from a simulation model. Care was taken to use as much as possible a detailed mechanism known to model acetylene oxidation in a wide range of experimental conditions. The mechanism proposed by Warnatz for the oxidation of alkanes and recently checked by Westmoreland for the modelling of a rich C_2H_2/O_2 flame was adopted as a starting point. This tested mechanism was complemented by formation and consumption reactions for C_4H_3, C_4H_4, C_4H_5 and benzene. The satisfactory agreement between calculated and measured profiles was turned to account to specify the main steps in the route to benzene. 45 refs.

47563 The behavior of polycyclic aromatic hydrocarbons during the early stages of soot formation. Lam, F.W. (Massachusetts Institute of Technology, Cambridge (USA)); Howard, J.B.; Longwell, J.P. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Experimental profiles of (1) aliphatic hydrocarbons, (2) polycyclic aromatic hydrocarbons (PAH), (3) total tar, and (4) soot obtained in a atmospheric pressure Jet-Stirred/Plug-Flow Reactor (JSR/PFR) are presented. The fuel was ethylene at an equivalence ratio of 2.37 (C/O = 0.79), corresponding to incipient sooting in the JSR. Temperature and residence time were 1630 K and 5.7 msec in the JSR, and 1580 K to 1540 K for 0.0 to 14.3 msec in the PFR. Samples were obtained using stainless steel water-cooled probes and analyzed for GC, GC/MS, and GC/FTIR. The partial equilibrium between C_2H_2, H_2 and the most thermodynamically stable PAH isomers was investigated using PAH thermochemistry. Acetylene and H_2 are essentially constant throughout the PFR. Light hydrocarbons are at, or decay towards, their partial equilibrium values. Smaller PAH species, such as benzene and phenylacetylene, show gradual increases with residence time in the PFR and approach partial equilibration with C_2H_2. The larger PAH species, such as pyrene, cyclopenta(cd)pyrene and phenathrene, do not reach partial equilibration with C_2H_2, and H_2, but show increases over two orders of magnitude toward their partial equilibrium values. From a mass balance, C_2H_2 consumption in the PFR is more than enough to account for the total mass added to soot and tar. From an analysis based on kinetic considerations, the observed soot surface growth rate per unit of C_2H_2 partial pressure varies from 2×10^{-3} to 4×10^{-3} g/cm^2·s·atm.

47564 A picture of soot particle inception. Harris, S.J. (General Motors Research Laboratories, Warren, MI (USA)); Weiner, A.M. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The authors have shown in earlier work that the ultimate soot loading in a sooting premixed flame is determined largely by processes that occur before the growth region, even though 90% of the soot mass is contributed by C_2H_2 surface growth. In this work they make the first measurements of how early soot formation kinetics vary with equivalence ratio. They find that the particle inception rate does not by itself control the ultimate soot loading. Molecules which grow to be larger than about 15 carbon atoms early in the flame form a thermodynamically stable pool of soot precursors. The coagulation of the heaviest of these precursors, which may be molecular weights near 1,000, contributes significantly to inception, and inception ceases when they are depleted. Species with somewhat lower molecular weight coagulate with the newly formed soot particles (surface growth) until they, too, are depleted. Oxidation - primarily by O_2 - competes with chemical growth and coagulation in determining the amount of soot exiting the particle inception zone.

47565 Some new observations concerning the mass growth of soot in premixed hydrocarbon-oxygen flames. Wieschnowsky, U. (Institut fuer Chemische Technologie, Darmstadt (West Germany)); Bockhorn, H.; Fetting, F. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The formation of soot in premixed, flat, low-pressure acetylene oxygen flames is studied by measuring volume fractions of soot, particle number densities and particle sizes by means of laser light scattering and extinction. Additionally, flame temperatures and composition are measured employing the Kurlbaum method and mass spectrometric analysis of microprobe samples, resp. The flames are seeded with CsCl and compared with unseeded flames providing the same soot volume fraction. The respective seeded and unseeded flames scarcely differ in flame properties, such as flame temperatures or chemical environments of the soot particles. The seeded and unseeded flames show similar soot appearance rates at different specific surfaces of soot particles. The specific surfaces of soot particles in the seeded and unseeded flames differ, because the soot particles in the seeded flames are prevented from coagulation by their electrical charges. The independence of surface growth rate on the specific surface of the soot particles hints to a growth mechanism with the rate determining steps in the pre-growth reactions. A qualitative picture is derived from a mechanism for growth and cyclization of PAH in sooting flames recently given by Frenklach and Warnatz. This qualitative mechanism offers a key to the understanding of the observed phenomenon, though a quantitative explanation at the present state of analysis is lacking.

47566 Soot aerosol dynamics in a laminar ethylene diffusion flame. Megaridis, C.M. (Brown Univ., Providence, RI (USA)); Dobbins, R.A. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A thermophoretic sampling technique is used to examine the soot morphological characteristics inside a coannular ethylene/air diffusion flame at atmospheric pressure. The data acquired with this sampling technique are combined with information obtained by others using optical diagnostics on an identical flame. The coatial variation of primary particle diameter, combined with particle velocity measurements performed by Santoro, allow the calculation of specific soot surface growth rate, primary particle number density, soot surface area and molecular flux of the growth species throughout the growth region. Specific soot burnout rates are also obtained throughout the oxidation region. A discussion about the spatial distribution of the soot aerosol processes is given. The particles are formed low in the flame ($z \simeq 5$ mm) on the fuel rich side of the flame sheet, close to the main reaction zone. They subsequently follow paths to the upper regions of the flame, growing through both agglomeration and surface growth reactions and finally they disappear entirely under the oxidative attack of various species. A bimodal integral solution of the aerosol dynamic equation that accounts for particle inception, free molecular coagulation and surface growth reactions is used to model the soot dynamics in the flame. This model

is used to study the soot formation and growth processes throughout the lower and intermediate portions of the flame along a path line that coincides with the annular region. An estimate of the particle inception rate is obtained as a result of these calculations.

47567 Correlations for smoke points and radiant emission of laminar hydrocarbon diffusion flames. Markstein, G.H. (Factory Mutual Research Corporation, Norwood, MA (USA)). pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A new method for smoke-point determinations based on measurement of radiant extinction by soot in the combustion products has been developed. Measurements were performed on laminar diffusion flames of C_3H_6, C_2H_4, C_3H_8 as well as C_3H_6-CH_4, C_3H_6-C_2H_4 and C_3H_6-C_3H_8 mixtures, with adiabatic flame temperature T_f and stoichiometric oxidizer-to-fuel mass ratio S varied independently by nitrogen addition to the fuel and nitrogen or oxygen addition to the air. The reciprocal smoke-point heat-release rate was found to satisfy the expression $Q^{-1}_{tot,sp} = G(T_f)(S^{1/2} - S^{1/2}_c)\Sigma w_i x_i c_i/\Sigma w_i x_i$ where $G(T_f)$ is a fourth-order polynomial, S_c is a critical value (~3) below which no smoke point can exist, c_i are coefficients that characterize the sooting tendency of fuel i, x_i its volume fraction in the fuel mixture, and w_i are weight factors introduced to obtain a linear mixing relationship. For the same fuels, and additional data obtained with C_2H_2 and C_2H_2-CH_4 mixtures, the radiant power as a function of heat-release rate was found to satisfy a universal correlation when both variables were normalized by their smoke-point values. Finally, the radiative fraction of heat-release rate at the smoke point was found to depend only on adiabatic flame temperature, increasing from about 0.20 at T_f = 2100 K to about 0.30 at T_f = 2600 K.

47568 Soot formation in diffusion flames of fuel/oxygen mixtures. Hura, H.S. (Princeton Univ., NJ (USA)); Glassman, I. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The effect of oxygen addition to the fuel on soot formation has been studied in coflow and counterflow diffusion flames of ethene and propane by performing smoke height, laser light extinction, temperature, and velocity measurements. In counterflow diffusion flames (CFDF's) established around a porous cylindrical burner, the equivalence ratio (ϕ) of the fuel/oxygen mixtures ranged from infinity to 2.60. Oxygen addition increased the soot formed in ethene flames to an ϕ of about 6.0. Greater oxygen addition resulted in a sharp reduction of the soot loadings and no soot was detected in flames with an $\phi < 3.0$. In contrast to ethene, oxygen addition to propane CFDF's first decreased the soot loadings until an ϕ of about 6.0. The soot loadings then increased and subsequently decreased sharply with the peak occurring at an ϕ of 3.5 and no soot was present in flames with $\phi < 2.60$. The smoke height measurements in coflow diffusion flames (CDF's) are in complete agreement with the CFDF results. Whereas oxygen addition to ethene decreased the sooting fuel flow rate substantially, an increase was measured for propane and isobutane. Moreover, CDF's with ϕ's less than about 3.6 for propane and 6.7 for ethene could not be stabilized due to flashback, and just before flashback propane flames were observed to soot copiously.

47569 Preferential diffusion and concentration modification in sooting counterflow diffusion flames. Axelbaum, R.L. (Univ. of California, Davis (USA)); Law, C.K.; Flower, W.L. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

An experimental investigation has been conducted on the influence of the mobility of inert additives on soot formation in propane and ethylene counterflow diffusion flames. Inerts used were helium, neon, argon, or krypton, and the results show that while the mobility of the inert has practically no effect when a small amount of inert is added to the oxidizer side, the influence is significant when added to the fuel side in that krypton, being the least mobile inert, yields the greatest soot loading while helium, being the most mobile, yields the least. By relating the spatially-resolved soot volume fractions to the corresponding profiles of temperature, velocity and species concentrations, it is demonstrated that this influence on soot loading is likely caused by concentration modifications of the fuel and the soot precursors due to the different mobilities of the inert additives.

47570 Experiments on the sooting limits of aerodynamically-strained diffusion flames. Du, D.X. (Univ. of California, Davis (USA)); Axelbaum, R.L.; Law, C.K. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

An experimental study has been performed with axisymmetric counterflow diffusion flames to investigate the influence of aerodynamic straining on the relevant sooting limits of the lower alkanes. The limits are defined by the critical strain rate at which either soot luminosity, soot particle light-scattering, or fluorescence is negligible compared to the appropriate background signal. The critical strain rates are found to be greatest for the sooting limit based on the fluorescence signal, with those based on luminosity and light-scattering being similar. The fluorescence signal, if attributed to polycyclic aromatic precursors, yields a limit that can be interpreted as the extinction of soot precursors and is suggested to be a possible limit for identifying a completely nonsooting flame condition. The separate effects of flame temperature and fuel concentration on the critical strain rates for soot extinction have also been studied. The results are indicative of how temperature and concentration influence the soot particle inception process and they show that both are potentially important parameters. The critical strain rates display an Arrhenius temperature dependence and this dependence is similar for all alkanes considered.

47571 The formation of polyhedral carbon ions in fuel-rich acetylene and benzene flames. Gerhardt, P. (Institut fuer Physikalische Chemie der Technischen Hockschule Darmstadt (West Germany)); Loeffler, S.; Homann, K.H. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A great number of different carbon particles with a supposedly closed-shell structure such as C_{60} have been detected in sooting flames. Mass spectra of positive and negative ions of this kind (called polyhedral carbon ions) are presented for low-pressure acetylene- and benzene-oxygen flames. By the use of C_6D_6 it could be confirmed that the particles with an even number of C atoms in fact do not contain hydrogen. Those with an odd number are much less abundant and carry 1 or 2 H atoms. The mass distributions of positive and negative polyhedral ions are quite different, the negative having more and larger particles. Concentration profiles of ions of both signs are reported, and the influence of the C/O ratio and the unburned gas velocity is investigated. The mechanism of formation of these particles is discussed. Arguments are presented that support the working hypothesis that the polyhedral carbon particles are formed from small soot particles rather than by a direct building-up from smaller molecular species.

47572 The influence of pressure and temperature on soot formation in premixed flames. Boehm, H. (Universitaet Goettingen (West Germany)); Hesse, D.; Jander, H.; Lueers, B.; Pietscher, J.; Wagner, H.G.; Weiss, M. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The formation of soot has been investigated in flat C_2H_4-air and C_6H_6-air flames, with special reference to low flame temperatures. Measurements of the threshold for soot formation show that as well as the high temperature threshold (slightly temperature dependent) there exists a low temperature threshold. For a given C/O ratio the mass of soot formed passes through a maximum between low and high temperature threshold at a temperature near 1600 to 1650 K. These soot yield curves are similar to those obtained in shock wave pyrolysis of benzene etc. by Graham, Frenklach et al. With increasing pressure the soot thresholds widen slightly. Their minima shift towards lower C/O ratio and the maxima of the soot yield curves rise. For the pressure dependence of the soot volume fraction finally formed, a P^2 dependence has been found at constant flame temperature for flame temperatures above 1650 K and C/O ratios

from 0.65 to 0.75. For benzene-air flames the pressure dependence is almost the same as for C_2H_4-air flames. The dependence of soot yield on the C/O ratio at constant flame temperature is a little weaker than the data obtained for constant flow velocity. Measurements of light absorption and light scattering along the flame axis show that coagulation and mass growth of the soot particles in the low temperature flames proceed in a similar way to that in flames at temperatures above 1600 K. 43 refs.

47573 Flowfield modeling of soot formation at elevated pressure. Moss, J.B. (Cranfield Institute of Technology, Bedford (England)); Stewart, C.D.; Syed, K.J. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A simplified two-equation model of soot formation is described which extends the laminar flamelet approach to combustion chemistry modeling and thereby admits application to turbulent non-premixed flames. The critical roles for mixture fraction and temperature are identified and extensive property maps have been generated experimentally in a laminar ethylene-air diffusion flame for purposes of model development and validation. Detailed measurements of mixture fraction by microprobe sampling and mass spectrometric analysis, temperature by fine wire thermocouple and soot volume fraction by laser extinction are reported. The problems of probe measurements in sooting regimes are briefly reviewed and a strategy based on transient thermocouple measurements, compensated for the effects of thermal inertia, is advocated. Measurements are reported up to pressures of 3 bar and compared with detailed model predictions. A model for soot formation, incorporating in an approximate manner the effects of nucleation, surface growth and agglomeration on particle number density and soot volume fraction, has been adapted to two-dimensional flame flowfield prediction. Encouraging agreement is achieved between the extensive data set and numerical simulation at atmospheric and elevated pressure.

47574 An investigation of soot formation in axisymmetric turbulent diffusion flames at elevated pressure. Flower, W.L. (Sandia National Laboratories, Livermore, CA (USA)). pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Turbulent, axisymmetric, ethylene-air diffusion flames were studied at pressures from 0.1 to 0.8 MPa for flame-tip Reynolds numbers from 5,300 to 21,000. Local and integrated soot volume fractions were determined from measurements of laser attenuation by the soot. Integrals of the soot volume fraction over the flame cross section increase with axial position in the early, soot-formation region of the flames, peaking at approximately one half of the visible flame length for all pressures. Radial soot-volume-fraction profiles are Gaussian, the width of the profiles increasing roughly linearly with axial position. For flames with the same flame-tip Reynolds number and residence time, the soot yield at the axial location of the peak soot volume fraction increases as $p^{1.4}$ for pressure p between 0.1 MPa and 0.5 MPa. At pressures greater than about 0.3 MPa, flames with long characteristic residence times have lower peak integrated soot volume fractions than comparable flames with relatively shorter residence times.

47575 The roles of innate oxygen and adsorbed oxygen in the chemistry of soot oxidation by oxygen atoms at 298 K. Wicke, B.G. (General Motors Research Laboratories, Warren, MI (USA)); Grady, K.A. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The authors have previously reported work examining the oxidation of soot by oxygen atoms at 298 K. They found that this oxidation produced CO_2 and CO gasification products, but that the chemistry was dominated by large net oxygen atom adsorption on the soot. In the present work they have used O^{16} and O^{18} in various sequential oxygen atom exposure experiments to study the roles of oxygen which is part of the as-prepared soot (hereafter referred to as innate oxygen) and adsorbed oxygen in the chemistry of this soot oxidation. The authors find that oxygen innate in the soot appears exclusively in the CO_2 gasification products. Adsorbed oxygen appears in both CO_2 and CO gasification products. A significant fraction of gasification product molecules contain exclusively oxygen atoms which had been adsorbed previously on the soot. That is, the oxygen atom responsible for the evolution of a gasification product molecule may not appear in this product molecule. They interpret these results to mean that the kinetically limiting reaction step in this soot gasification is product desorption; heat liberated by adsorption of an oxygen atom on the soot produces sufficient local surface energy to allow the activated desorption of CO_2 and CO.

47576 The structure of turbulent nonpremixed flames. Bilger, R.W. (Univ. of Sydney (Australia)). pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Flamelet theories are examined in the context of turbulent nonpremixed combustion. The criterion requiring that the reaction zone be thinner than the Kolmogoroff length scale is converted to one in which the range of mixture fraction over which reaction occurs is compared with the scalar scale for the small scale fluctuations. It is found that the criterion is violated in many of the flames of interest, particularly away from the nozzle in jet flames and in recirculating flows. Laser imaging data for scalar mixing is used to illustrate the structure of quasi-equilibrium distributed reaction (QEDR) flames at high Damkohler number. The structure is found to tend toward that of the scalar dissipation. The apparent success of flamelet theories in predicting mean concentrations of CO in hydrocarbon flames is ascribed to the metastable equilibrium of rich mixtures arising from chain terminating reactions of radicals with the fuel. Differences in flame structure for piloted jet diffusion flames near extinction of methane and $CO/H_2/N_2$ fuels are discussed in terms of these fluid dynamic and kinetic insights. 43 refs.

47577 Study of molecular mixing and a finite rate chemical reaction in a mixing layer. Cetegen, B.M. (Univ. of Connecticut, Storrs (USA)); Sirignano, W.A. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

This paper concerns an analytical study of molecular mixing and finite rate chemical reactions in an infinite row of two dimensional vortices representing a mixing layer. Diffusion equations for reacting and non-reacting species are solved locally in a Lagrangian frame of reference following material elements. The flowfield is prescribed for the solution. The concentration distributions in the vortex structure are composed from these analytical solutions and presented for several cases. The probability density functions (pdfs) constructed from these distributions show similarities to those from the mixing layer experiments.

47578 Premixed combustion in a vortex. Peters, N. (Institut fuer Allgemeine Mechanik, Aachen (Germany, F.R.)); Williams, F.A. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

An asymptotic analysis for large Peclet numbers has been performed in order to describe the roll-up of a premixed flame by a single vortex. In this limit the process consists of two steps: (1) the fast-time inviscid roll-up of the flame surface as a passive surface into a spiral around the vortex, and (2) the slow-time flame propagation between the spirals. Since the spirals are closer to each other towards the center of the vortex, the latter process leads to the development of a reacted core, similar to that found by Marble for diffusion flames. The growth rate of the reacted core is derived first in terms of a more global order-of-magnitude estimate, then a detailed mathematical analysis is performed to test the estimate. Its essential parts are a transformation to Lagrangian coordinates and an asymptotic analysis of the resulting equation. The flame propagation between the spirals is assumed to be quasi-stationary. The flames are stretched by the convective motion and may extinguish for Lewis numbers larger than unity. Finally, under an approximation of radial symmetry, the radial mass flow rate produced by gas expansion is calculated.

47579 Interaction of a vortex ring and a laminar flame. Jarosinski, J. (McGill Univ., Montreal (Canada)); Lee, J.H.S.; Knystautas, R. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Vortex bubbles of various diameters are generated in a vortex generator driven by a loudspeaker and propagate downwards in a vertical flame tube to interact head on with a laminar flame. Different combustible mixtures can be used in the flame and the vortex generator. Successful ignition of a combustible vortex bubble is only possible if the spark is located at the vortex core of the bubble and not elsewhere. This suggests that the tangential velocity gradient causes the flame to be quenched by the flame stretch mechanism as in a stagnation flow. In the penetration of the vortex bubble into the hot products behind the flame, ignition is never observed to occur at the bubble surface. Instead the hot products are entrained into the bubble and enter through the rear stagnation region. Ignition occurs when sufficient hot products have been entrained and mixed with the combustible gases in the bubble. Ignition is observed to originate near the bubble axis and spread radially outward to be entrained into the vortex core. Measurements of the entrainment time (time between the entrance of the bubble into the hot products and ignition) indicate that the entrainment time is very weakly dependent on the vortex circulation in accord with the observation of Maxworthy of non-reacting vortex rings. Combustion time (period between ignition and complete burning of the vortex bubble) is found to be independent of the mixture composition and is of about the same order of magnitude as the entrainment time.

47580 An investigation of the structure of a laminar nonpremixed flame in an unsteady vortical flow. Lewis, G.S. (Stanford Univ., CA (USA)); Cantwell, B.J.; Vandsburger, U.; Bowman, C.T. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Although organized vortical motions have been observed in a variety of turbulent flames, there have been only a few experimental studies which have directly examined the structure of a flame imbedded in an unsteady vortical flow. In the present work, this problem is investigated using a laminar co-flowing jet flame in which a periodic vortical motion is induced by acoustic excitation of the fuel stream. A variety of optical planar imaging techniques are employed to define the instantaneous flame structure. Particle tracking is used to obtain the instantaneous two-dimensional velocity field. These measurements are combined to follow the evolution of the flame in the unsteady velocity field over one cycle of the excitation. The flame is observed to break up into a series of axisymmetric flamelets which convect and distort under the influence of buoyancy and the vortical flow. When the velocity field is viewed in a frame of reference moving with the flamelets the flow pattern is seen to consist of a pair of saddle points on either side of the flow centerline near the flame tip and a single saddle point on the centerline near the base of the flame. This latter saddle point is also evident in images of light scattered from TiO_2 particles added to the fuel stream. Entrained fluid is fed into a large axisymmetric vortex surrounding the base of the flame. Because of heat release, the flame acts as an effective volume source in the flow. A high strain rate exists on the centerline at the base of the flame, and planar laser-induced fluorescence measurements of the concentration of OH show local extinction of the flame.

47581 Evolution of vortical structures in flames. Gutmark, E. (Naval Weapons Center, China Lake, CA (USA)); Parr, T.P.; Parr, D.M.; Schadow, K.C. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The detailed substructure of the large-scale coherent vortices in the mixing layer of an annular diffusion flame was studied using the Planar Laser Induced Fluorescence (PLIF) visualization technique. The formation, evolution and interaction of the coherent vortices and the various modes of azimuthal structures were visualized. These structures dominate the large- and fine-scale mixing processes in the flame and thus affect the combustion rate and stability characteristics. The concentration of the hydroxyl radical was used to visualize the reaction zones. The vortical structures were generated and stabilized by forcing the air jet at various instability frequencies. The vortex merging process, which is the main growth mechanism of the shear layer, was simulated and investigated as well. Phase-averaged measurements were used to get the global features of flow structures. Instantaneous planar measurements which were obtained on- and off-axis and in cross-sections perpendicular to the axis, revealed the details of the complex three-dimensional character of the flame. This three-dimensionality of an apparently axisymmetric flame is related to the amplification of high azimuthal modes of jet instability. The growth of these secondary structures is related to the transition of the coherent structures to small-scale turbulence.

47582 The role of the recirculation vortex in improving fuel-air mixing within swirling flames. Chen, Rueyhung (Univ. of Michigan, Ann Arbor (USA)); Driscoll, J.F. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Swirl flames are unique in that the fuel-air mixing rate can be varied by controlling the amount of swirl. Flow visualization shows how internal recirculation helps to enhance the mixing. The engulfment mechanism is similar to that of a simple jet flame but is enhanced because of two factors that increase the fuel-air contact area. First, the recirculation zone acts like a large eddy with a characteristic velocity and length scale that are much larger than those associated with eddies in a simple jet. The active role of the recirculation zone contradicts a previously-held concept that the recirculation zone is a passive obstacle and that its internal velocity is not important. Air in entrained into the toroidal vortex primarily in the downstream region of the vortex. A second reason why mixing is more intense within swirling flames than within jet flames is that there is impingement of opposed jets at the forward stagnation point. Thus pressure gradients, which are not present in simple jets, enhance the mixing rates. Flame length, which is a measure of overall fuel-air mixing, was found to have a different scaling in swirl flames than for simple jet flames. The physical reasons are explained by a scaling which was developed and which explains four trends in the flame length data. It is proposed to use a general, nondimensional circulation parameter that allows for general comparison of mixing efficiencies of swirl, bluff-body, and dump-combustor flames.

47583 Experimental evaluation of the fractal geometry of flamelets. Gouldin, F.C. (Cornell Univ., Ithaca, NY (USA)); Hilton, S.M.; Lamb, T. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The fractal character of flamelets in premixing turbulent V-flames is evaluated through combined tomographic and time-series light scattering measurements. Fractal dusts and curves generated by the intersection of lines and planes with flamelets surfaces are observed. Algorithms for evaluating fractal character from the experimental data are described and discussed. The results, obtained for several different flame conditions, indicate that flamelets can be represented by fractal surfaces with a fractal dimension and inner and outer cutoffs to fractal behavior. The outer cutoff is several times larger than the integral scale in the reactant flow, while the inner cutoff is an order of magnitude larger than the Kolmogorov scale. The fractal dimension which is implied for the flamelet surface from these measurements is approximately 2.1 which is well below the expected value of approximately 2.37. Several reasons for this difference are offered including low absolute turbulent intensity and low turbulence Reynolds number.

47584 Fractal-like character of flamelets in turbulent premixed combustion. Murayama, Motohide (Univ. of Tokyo (Japan)); Takeno, Tadao. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The fractal-like character of the laminar flamelet surface in turbulent premixed combustion was studied to determine if the surface is truly a self-similar fractal or not. The turbulent burner flame of a

lean methane-air mixture stabilized in an isotropic homogeneous turbulent flow was used, and the laser tomography technique was adopted to visualize the instantaneous image of two-dimensional sections of the surface. The analysis of the images in vertical and horizontal sections revealed that the surface actually exhibits fractal behavior in a narrow range of scale. The inner cutoff scale was the laminar flame thickness, while the outer cutoff scale was the burner size. The derived fractal-like character, represented in terms of the fractal dimension and the fractal degree, was found to depend on the orientation and position of the section. The fractal dimension was much smaller than those measured for nonreacting various turbulent flows, and was larger for the vertical section than the horizontal sections, and increased towards downstream. It increased with the turbulence intensity of the approach flow. However, it is suggested that the flamelet surface does not behave as a passive surface in the given turbulent flow, and hence the observed fractal-like character is not directly connected to the turbulence characteristics of the approach flow. It should rather represent certain aspects of the flamelet itself.

47585 **Fractal geometry applications in turbulent combustion data analysis.** Strahle, W.C. (Georgia Institute of Technology, Atlanta (USA)); Jagoda, J.I. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Application of fractal geometry concepts is made to some premixed turbulent combustion data and the geometry is found to yield some new visual concepts in analysis of the data. Moreover, techniques through fractal interpolation are shown to aid in reconstruction of decimated data or in a reasonable construction of missing data in a low data rate acquisition situation. Application is made to hot film anemometry data in an approach cold flow and Rayleigh scattering density data in a premixed flame. The fractal character of the time series data is shown and a new visual concept of the multifractal probability density function introduced. The different fractal character of the two data types is clearly shown. The iterated function sequence technique for data reconstruction is introduced and some constraints of probability theory are removed by alternate fractal concepts.

47586 **A simulation with a cellular automaton for turbulent combustion modeling.** Saied, R.; Borghi, R. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The modeling of turbulent combustion is a crucial problem for the numerical simulation of flames and combustion chambers. An important point in this respect is the relevance of $k^{1/2}/u_L$ (the square root of turbulence kinetic energy divided by the laminar flame speed) as a parameter to the mean reaction rate for premixed turbulent flames. In order to get more insight to this problem, the authors have built a special simulation method, of the type of a cellular automaton, which includes all the physical phenomena that are thought to be important. The result of several statistical simulations gives a new closure formula that can be included in classical turbulent combustion models; it takes explicitly into account $k^{1/2}/u_L$, which plays a role in the so called wrinkled flame regime only.

47587 **Molecular mixing and chemical reactions in turbulent shear layers.** Broadwell, J.E. (California Institute of Technology, Pasadena (USA)); Mungal, M.G. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A model is proposed for describing chemical reactions in a turbulent shear layer. The model exhibits explicitly the effects on the overall reaction rate of equivalence ratio and of the Schmidt, Reynolds and Damkoehler numbers. The model predictions compare favorably with experimental results in which all of these parameters are varied. The comparisons imply that the Reynolds number influences the effective reaction rate for Re as high as 10^6 and that the reaction rate becomes mixing limited for values of the Damkoehler number, based on time of flight to the measuring station and the overall reaction time, of about 40.

47588 **The importance of time-dependent flame structures in stretched laminar flamelet models for turbulent jet diffusion flames.** Haworth, D.C. (General Motors Research Laboratories, Warren, MI (USA)); Drake, M.C.; Pope, S.B.; Blint, R.J. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The stretched laminar flamelet model provides a convenient mechanism for incorporating realistic chemical kinetics into calculations of turbulent nonpremixed flames. In the standard flamelet model, two scalars, a mixture fraction ξ and scalar dissipation χ (a measure of flamelet stretch) suffice to specify the local instantaneous thermochemical state in the turbulent flow. One shortcoming of the flamelet approach is the implicit assumption that the reaction zone structure of laminar flamelets can respond on a time scale that is fast compared to the time scale of changes in mean scalar dissipation in the turbulent flow. Analysis of the response of a one-dimensional unsteady strained diffusion layer to arbitrary time-dependent strains is presented. This analysis suggests that laminar flames cannot approach the equilibrium (zero strain) structure as rapidly as the flamelet model implies far downstream in the jet; the flamelet model breaks down in the far jet. An ad hoc modification to the flamelet model is made to account for the limited response of the diffusive layer to time-varying strain rates. In a $CO/H_2/N_2$-air turbulent jet diffusion flame, the modified flamelet model yields a substantially slower approach to chemical equilibrium and improved agreement with experimental data compared to the standard flamelet model. This suggests that the final approach to equilibrium may be limited by the nonzero response time of flamelet chemical structure to the rapidly decaying strain rates encountered downstream in the turbulent jet. In the context of flamelet models, transient effects may be more important than previously assumed.

47589 **Non-premixed turbulent CO/H_2 flames at local extinction conditions.** Correa, S.M. (General Electric Company, Schenectady, NY (USA)); Gulati, A. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The physical phenomena responsible for the local extinction of diffusion flames due to intense turbulence are discussed and a computational model for a jet flame under such conditions is presented. In the model, combustion chemistry is represented by two-body shuffle reactions, taken to be infinitely fast or frozen, and three-body recombination reactions. The scalar dissipation rate field is examined for critical values below which the two-body reactions are assumed to be in partial equilibrium and above which they are assumed to be frozen and the gas therefore unburned. The kinetics of the recombination reactions are activated for the former fraction of the gas. This approach is implemented in a shear-layer finite-volume averaged Navier-Stokes model with k-ϵ/assumed shape pdf sub-models for turbulence. The model is applied to a Re = 15,000 pilot-stabilized 40% CO/10% H_2/50% N_2 jet flame for which laser-based spectroscopic data on major species and temperature are presented. The fuel is chosen to maximize the probability of local extinction. The model is useful for moderate to high Reynolds number diffusion flames.

47590 **Spontaneous Raman Measurements in turbulent $CO/H_2/N_2$ flames near extinction.** Masri, A.R. (Univ. of Sydney (Australia)); Dibble, R.W. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Using the Rayleigh-Raman scattering technique, simultaneous space- and time-resolved measurements of temperatures and the concentration of CO, CO_2, H_2, H_2O, O_2 and N_2 have been made in pilot stabilized turbulent nonpremixed flames of $CO/H_2/N_2$ near extinction. Five photomultiplier tubes are dedicated to monitor the background chemiluminescence which is broadband and interferes in varying degrees with all the Raman lines. This interference is corrected for using correction factors which relate the charges collected on each of these monitors to the chemiluminescence interference with each of the Raman lines. It is found that as the turbulent mixing rates increase, all reactive scalars which otherwise

like close to the equilibrium limits, drift gradually away from those limits due to the chemical kinetic effects becoming significant. Unlike methane flames near blowoff, localized extinction does not occur in $CO/H_2/N_2$ flames and the mechanism of extinction for these flames is therefore different. Inferences are made regarding the spatial structure of the reaction zones in turbulent nonpremixed $CO/H_2/N_2$ flames with finite rate chemical kinetics.

47591 Laser Mie scattering measurement of mean mixture fraction density and temperature by conditional seeding in a turbulent diffusion flame. Stepowski, D. (Universite de Rouen, Mont Saint Aignan (France)); Cabot, G. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The laser Mie scattering technique is used to measure the mean distributions of seed particles in a turbulent diffusion flame of a jet of hydrogen-air issuing in a coflowing air stream. Experiments are successively performed by seeding only the fuel channel and then only the coflow air. The conditional data are used to derive mean values of mixture fraction, density and temperature in the mixing flow. This technique appears to be well suited for measurements in diffusion flames where turbulent mixing is the dominant process and would be a very powerful tool for turbulence study in such flows if the two conditional seeding data could be obtained simultaneously.

47592 Near-field instantaneous flame and fuel concentration structures. Namazian, M. (Altex Technologies Corporation, Los Gatos, CA (USA)); Kelly, J.T.; Schefer, R.W. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Simultaneous two-dimensional CH_4 and CH imaging data are obtained and analyzed in the near field of non-premixed jet and bluff-body stabilized flames. CH is used as an indicator of the reaction zone. Both flames are found to have similar CH/CH_4 structures located in the vicinity of the 0.1 CH_4 concentration contour. In both cases, the flame zone consists of a narrow envelope that follows the fuel structure movements. Large-scale fuel structure protrusions are shown to produce gaps in the reaction zone. The data, combined with mixing time estimates for eddies smaller than the experimental resolution, support the concept that the fuel and air are premixed at the flame initiation point. Fuel concentrations in the reaction zone are substantial and range approximately within the flammability limits of the fuel at ambient temperature. The data are consistent with a dissipative eddy model, where reaction is limited to small isolated premixed structures within the flow, reaction occurs over a region several times thicker than the laminar flame thickness and the reaction is bounded by a fuel concentration range similar to the flammability range of the fuel.

47593 Direct numerical simulations of a two-dimensional reacting, spatially developing mixing layer by a spectral-element method. Givi, P. (State Univ. of New York, Buffalo (USA)); Jou, W.H. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The spectral-element method, a numerical scheme that combines the accuracy of spectral methods with the versatility of finite element techniques, has been employed to study the mechanisms of mixing and chemical reactions in a diffusion flame stabilized on a two-dimensional planar mixing layer. The results of simulations of the harmonically forced, spatially developing flow are statistically analyzed to examine the compositional structure of the flame near quenching. The results indicate that as the flame approaches extinction, the mean and the rms values of the reactant concentrations decrease while those of the product concentration and temperature increase. This behavior is enhanced by increasing the hydrodynamics characteristic time (reducing the local Damkohler number) and is consistent with that observed experimentally.

47594 Finite chemical reaction rate and local equilibrium effects in turbulent hydrogen-air diffusion flames. Bockhorn, H. (Universitaet Heidelberg (West Germany)). pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

In this study, a high Reynolds number turbulent hydrogen-air diffusion flame, ample experimental data of which are reported in the literature, is numerically simulated. The turbulent combustion model is based on a detailed chemical mechanism for the $H_2/O_2/N_2$ system comprising 45 elementary reactions of eleven chemical species. In addition to employing a commonly used turbulence model, the species conservation equations are solved. The source terms in the latter equations are treated by means of a pdf-closure relaxing the assumption of statistically independent variables. This necessitates the computation of variances and covariances of the variables entering the chemical rate expression. It has been attempted to model preferential diffusion of hydrogen and hydrogen atoms directly. The combustion model, which involves no additional assumptions with respect to chemistry, yields reasonably good agreement between predictions and measurements, clearly identifying non-equilibrium effects in hydrogen and oxygen mass fractions. The break-through of oxygen onto the axis of the hydrogen jet, which is demonstrated by the measurements, is predicted as well. Superequilibrium mass fractions of OH are computed in addition to a slow approach of the NO mass fractions towards local equilibrium. Preferential diffusion of hydrogen and hydrogen atoms enlarges the departure from local equilibrium, but is a minor effect in this high Reynolds number diffusion flame.

47595 Origin and manifestation of flow-combustion interactions in a premixed shear layer. Ghoniem, A.F. (Massachusetts Institute of Technology, Cambridge (USA)); Krishnan, A. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). DOE Contract FG04-87AL44875. From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The interactions between the flow field and the combustion process in a premixed shear layer are investigated using the results of numerical simulation. The reaction is governed by a finite-rate Arrhenium kinetics, the flow is compressible and at high Reynolds number, heat release is moderate and molecular heat and mass diffusivities are finite. The thickness of the reaction zone and that of the vorticity layer are approximately the same. Lagrangian simulations are obtained using the vortex and transport element methods. Results indicate that at the early stages, a reacting shear layer behaves like a laminar flame. During the growth of the roll-up eddy, the rate of burning is strongly enhanced by the entrainment fluxes that lead to the swelling of the reaction zone, and the total rate of product formation can be approximated by the unstrained laminar burning velocity times the flame length measured along the line of maximum reaction rate. Following the burning of the eddy core, the strain field along the eddy boundaries causes a noticeable thinning of the reaction zone and reduces the rate of burning. Baroclinic vorticity generation due to the acceleration of fluid elements in the density gradient is the most important mechanism by which combustion affects the flow field. It augments the overall volumetric entrainment into the eddy core, and causes an entrainment asymmetry with a bias towards the products. The generated vorticity extends the growth period of the eddy and imparts on it an extra mean convective motion.

47596 Buoyant diffusion flames. Chen, L.D. (Univ. of Iowa, Iowa City (USA)); Seaba, J.P.; Roquemore, W.M.; Goss, L.P. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Planar visualization was employed to study flame structure and low frequency flame oscillation. Two distinct vortices were visualized in the flames studies: large toroidal vortices outside the luminous flame and small roll-up vortices inside the luminous flame. The flame oscillation frequency and the convective velocity of the toroidal vortices were measured for ethylene, methane, and propane diffusion flames over a wide range of test conditions. The frequency was typically in the range 10 to 20 Hz and the convective velocity was approximately, 0.8 m/s. The frequency of the toroidal vortices was found to correlate with the flame oscillation frequency. The potential effects of the toroidal vortices on the flame dynamics

at low fuel flow rates are discussed, for example, low frequency flame oscillation, non-linear flame bulge motion, and quenching of the luminous flame surface.

47597 Transition and stability of turbulent jet diffusion flames. Coats, C.M. (Univ. of Leeds (England)); Zhao, H. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Experiments have been carried out on two methane jet diffusion flames stabilized on burners with the same port diameter but different internal geometries to examine in detail the processes controlling transition and stability and identify any casual links between them. One of the burners was a parallel-sided tube and the other was a contoured nozzle. In both flames transition from laminar to turbulent combustion was associated with changes in the structure of the central gas jet, being triggered in one case by pipe-flow turbulence and in the other by hydrodynamic instability of the shear layer bounding the jet potential core. Transition in the main body of the flame effectively suppressed the low-frequency instability which dominated both flames at lower Reynolds numbers. In both flames it appeared that lift-off was precipitated as a result of invasion of the laminar flame base by turbulence present in the central gas jet. The lifted flames remained sensitive to the initial conditions to a considerable height above the burner and showed evidence of a cellular type of structure under certain conditions, suggesting that models which assume flame propagation into fully developed turbulent flow are not always appropriate for analyzing the stability of lifted flames in the near-burner region.

47598 Scalar dissipation rates in turbulent jets and jet diffusion flames. Effelsberg, E. (Institut fuer Allgemeine Mechanik, Aachen (Germany, F.R.)); Peters, N. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Laser Rayleigh scattering and laser Doppler measurements have been performed in round propane air jets and in the stabilization region of a lifted propane air diffusion flame. While the laser Doppler measurements provide the necessary information about the mean flow field the Rayleigh scattering measurements were performed in order to obtain new data about the turbulence structure of the scalar field. The mixture fraction and its spatial gradient was measured locally, such that the scalar dissipation rate and its probability density function (pdf) could be obtained. The pdf is compared with a lognormal distribution. It is found that its variance σ is remarkably constant within the entire jet and in the flame. The experimental results are compared with standard k-ε-type model predictions.

47599 Measurement of three-dimensional concentrations in turbulent jets and flames. Long, M.B. (Yale Univ., New Haven, CT (USA)); Yip, B. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Laser-based techniques for obtaining measurements of a three-dimensional scalar field in turbulent jets and flames are described. In one experiment, three-dimensional scalar gradients are determined by detecting the scattered light intensity from two parallel illumination sheets intersecting the flow. Another experimental approach gives more complete three-dimensional data by scanning a single laser sheet through the flow, and recording the scattering corresponding to different sheet locations. Data from nonreacting and reacting flows are presented and important factors in the measurement techniques are discussed.

47600 Raman/Rayleigh and Mie-scattering measurements in a reverse flow reactor close to extinction. Mansour, M.S. (Univ. of Sydney (Australia)); Bilger, R.W.; Dibble, R.W. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A reverse flow reactor (RFR) has been designed and developed to create a partially premixed flame with intense turbulent mixing and mean mixture fraction close to stoichiometric with fluctuations such as to keep most of the mixture within the flammability limits. This is used to study chemical kinetics effects on turbulent flame structure at high mixing rate, χ, as well as providing a bank of data for testing and developing theoretical models. Flame characteristics and extinction limits have been studied. Pulsed spontaneous Raman/Rayleigh measurements are presented and compared with Mie-scattering, and thermocouple measurements. The data presented in this paper are for flames close to extinction at low residence times (2 to 10 ms) and show significant effects of finite rate chemistry. Partially premixed flames show a lower stability limit compared with the fully premixed situation indicating faster chemistry due to the existence of rich pockets which may be responsible for stabilizing the flame at low equivalence ratio. The mean concentrations by Mie-scattering technique and temperature measured by a thermocouple are in good agreement with that of the Raman/Rayleigh technique, but the rms levels of the Mie concentration are much higher because of the noise associated with the Mie signal due to differential diffusion and other effects.

47601 Equilibrium computations of multiphase nonideal electrolytic systems and structure of turbulent reacting dissolving jets. Chan, S.H. (Univ. of Wisconsin, Milwaukee (USA)); Janke, P.J.; Shen, T.R. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The objectives of the paper are two-fold. First, a method has been presented and a computer program developed for the computation of chemical equilibrium of complex reacting, nonideal, multiphase and electrolytic mixtures. Validity of the program has been confirmed by comparing the calculated values with experimental solubility data of three binary systems. Applications have been made to hydrogen chloride gas and aqueous ammonia reacting dissolving systems. Extensive state relationships as a function of mixture fraction have been generated for ammonia solutions over a wide range of ammonia concentrations. The second objective is to investigate the structure of a turbulent, gaseous, reacting, dissolving hydrogen chloride jet submerged in an aqueous ammonia bath. The use of HCl(g) as oxidizer and NH_{aq} as fuel has been of recent interest to simulate the turbulent combustion of a halogen gaseous oxidizer with an alkali liquid metal fuel. With the state relationships generated, the k-ε-g turbulent model, the local homogeneous two-phase flow approximation and a clipped Gaussian probability function for the square of the mixture fraction fluctuations, predictions have been made for the plume penetration length, temperature, void fraction and concentration profiles of the plume. It is found that the total plume penetration length is controlled by the extend of vaporization of the bath liquid, which is governed by the concentration of the ammonia fuel. The theoretical calculations are found in good agreement with the recent experimental data, which include the maximum plume temperature, the plume penetration lengths and the void fraction profile.

47602 The straining of premixed turbulent flames. Abdel-Gayed, R.G. (Leeds Univ. (England)); Bradley, D.; Lau, A.K.C. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

This paper discusses the meaning to be attached to the Lagrangian strain rate of a material surface element, under conditions of turbulent burning of a gaseous premixture. It is important to resolve this question in order to utilize strained laminar flame data in turbulent modeling. It is postulated that material line elements of the flame surface always tend towards the axis of maximum principal strain. As a consequence, Lagrangian pdfs for flame strain rate can be derived from assumed Eulerian pdfs of strain rate and these are presented. Partial quenching of premixed C_3H_8-air flames at different levels of turbulence, in a fan-stirred bomb, was observed by high speed schlieren photography. The proportion of the total flame surface are that was supporting propagation was measured. This was equated to the probability that for propagation, the strain rate was less than a limiting quenching strain rate, evaluated from pdfs derived as described above. Experiments were at three equivalence rations and it was found that the quenching strain rate was appreciably higher than that observed by Law et al for laminar flames of

the same composition, and about three times that predicted theoretically by Stahl et al. Reasons for these discrepancies are discussed.

47603 Velocity and scalar fields of turbulent premixed flames in stagnation flow. Cho, P. (Univ. of California, Davis (USA)); Law, C.K.; Cheng, R.K.; Shepherd, I.G. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). DOE Contract AC03-76SF00098. From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Detailed experimental measurements of the scalar and velocity statistics of premixed methane/air flames stabilized by a stagnation plate are reported. Conditioned and unconditioned velocity of two components and the reaction progress variable are measured by using a two-component laser Doppler velocimetry technique and Mie scattering technique, respectively. Experimental conditions cover equivalence ratios of 0.9 and 1.0, incidence turbulence intensities of 0.3 to 0.45 m/s, and global stretch rates of 100 to 150 sec^{-1}. The experimental results are analyzed in the context of the Bray-Moss-Libby flamelet model of these flames. The results indicate that there is no turbulence production within the turbulent flame brush and the second and third order turbulent transport terms are reduced to functions of the difference between the conditioned mean velocity. The result of normalization of these relative velocities by the respective velocity increase across laminar flame suggests that the mean unconditioned velocity profiles are self-similar.

47604 The influence of turbulence on the burning velocity of premixed CH_4-H_2 flames with different laminar burning velocities. Liu, Y. (Universitaet Karlsruhe (West Germany)); Lenze, B. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The influence of the turbulence on the turbulent burning velocity S_T of a premixed flame, characterized by a flat flame front stabilized in a stagnation flow was investigated using a two component Laser-Doppler-velocimetry (LDV) technique. The use of different CH_4-H_2 combustion mixtures enabled the laminar burning velocity S_L to be varied between 0.18 m/s and 0.72 m/s. The turbulent intensities u' generated in the experiments ranges from 0.1 m/s up to 1.2 m/s. The turbulent burning velocity could be precisely determined due to the simple configuration of the flat flame front. The results show that, for lean flames and for low u' values S_T linearly increases with u', the slope of this function being dependent on L_L and increasing approximately proportional to $\sqrt{S_L}$. Furthermore, the data obtained from lean flames within the present investigations comply well to the relationship: $S_T = S_L + 5.3 \cdot S^{1/2}{}_L \cdot u'$. No noticeable differences could be observed regarding different CH_4-H_2 mixture compositions, provided S_L remained constant. Initial measurements of rich flames have shown that the effect of turbulence intensity on rich flames is different from that on lean flames. A dependence of the turbulent burning velocity on turbulent length scales could not be found for the stagnation flame system.

47605 Time scales of the scalar field in turbulent premixed conical flames. Boukhalfa, A. (Centre National de la Recherche Scientifique, Orleans (France)); Goekalp, I. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The temporal characteristics of five conical methane-air turbulent premixed flames are investigated by one-point laser induced Rayleigh scattering technique. They correspond to combinations of three exit Reynolds numbers and three equivalence ratios and are representative of the wrinkled flame regime, the corrugated flame regime and the thickened flame regime of premixed turbulent combustion. The density pdfs are explored to assess the structural differences between these flames. It is found that the constant levels of the intermediate burning states in the density pdfs decreases with increasing large eddy Damkoehler number and reach a plateau value for the highest Damkoehler number flames. The scalar field time statistics of these flames are investigated through the density spectra, flamelet crossing frequencies and the integral time scale of the density field. This investigation shows that the flame closes to the wrinkled flame model has a singular behavior, whilst the four others behave very similarly. For a constant exit Reynolds number, temporal statistics of the scalar field do not depend on the equivalence ratio, while, for a constant equivalence ratio, they strongly depend on the cold flow characteristics. In particular, the flamelet crossing frequencies increase with the mean exit velocity, whilst the integral time scale of the scalar field decreases. In order to provide some modeling ideas, the relationships between the mean flamelet passage time and the integral time scale of the cold flow, on the one hand, and the most energetic and the most dissipative frequency ranges of the density spectra and the maximum value of the flamelet crossing frequency, on the other hand, are explored.

47606 Mean reaction rates in premixed turbulent flames. Bray, K.N.C. (Cambridge Univ. (England)); Champion, M.; Libby, P.A. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). DOE Contract FG03-86ER13527. From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A revised model for the mean rate of creation of products in premixed turbulent combustion is developed on the basis of an extension of the Bray-Moss description of the thermochemistry of such combustion to include one-point, two-time information. The model provides the basis for follow-on studies incorporating the influence of the rate of strain on the rate of creation of product at each flamelet crossing and variations in the time scale of such crossings within a turbulent flame. On the basis of presently available data obtained from laboratory flames with various geometries and with modest to small turbulent intensities the effects of rate of strain and the variation of time scale are both found to be small under the conditions of these experiments.

47607 Reaction rates in premixed turbulent flames and their relevance to the turbulent burning speed. Cheng, R.K. (Lawrence Berkeley Laboratory, CA (USA)); Shepherd, I.G.; Talbot, L. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). DOE Contract AC03-76SF00098. From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

An experimental procedure to measure the local reaction rate, w, in premixed turbulent flames is presented. It utilizes the flame crossing frequency sub-model for the reaction rate formulated by Bray-Champion-Libby (BCL) for turbulent flames with unstrained or equally strained flamelets. The experiments involve measuring the flame crossing frequencies and the conditioned mean velocity of two components using respectively Mie scattering and two color LDA techniques. A method of analysis has also been developed to deduce the turbulent burning speed from $\tilde{w}$. The turbulent/laminar burning speed ratio is obtained by integrating the reaction rates measured along 2D mean Lagrangian flowlines through the flame brush. The flowlines are traced automatically using feedback control for positioning the LDA probe. The method has been applied to study five v-flames and four large Bunsen type conical flames. The distributions of $\tilde{w}$ are well predicted by the BCL model. The turbulent flame speed results based on $\tilde{w}$ are in excellent agreement with those obtained by the conventional flame orientation method. The main advantage of using this method to determine the turbulent burning speed is that the uncertainties are lowered. Furthermore, it can be applied successfully to flames with complex geometries such as the flame tip region of a conical flame.

47608 The stochastic flamelet model of turbulent premixed combustion. Pope, S.B. (Cornell Univ., Ithaca, NY (USA)); Cheng, W.K. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). DOE Contract AC02-83ER13038. From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A new stochastic model is presented and used to calculate the properties of turbulent premixed flames in the flame-sheet regime. The flame sheet is represented statistically by infinitesimal flamelets, each characterized by its position, its unit normal vector, and its (infinitesimal) area. The evolution of the position and normal are completely determined by the fluid velocity and its spatial derivatives following the flamelet, which are modeled by stochastic processes. The flamelet area changes by stretching caused by

velocity gradients, by the propagation of cusps, and because of curvature. An additional model is developed to account for the latter two mechanisms. The Stochastic Flamelet Model is used in conjunction with the joint pdf approach to make calculations of nonstationary, statistically plane turbulent premixed flames. These calculations demonstrate the practicality of the method and illustrate its attributes. Because it contains a natural and comprehensive statistical description of the flame sheet, the model allows the essential physical processes to be incorporated in a straightforward manner.

47609 Strained laminar flamelet calculations of premixed turbulent combustion in a closed vessel. Cant, R.S. (Cambridge Univ. (England)); Bray, K.N.C. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A new turbulent burning rate model for premixed combustion is described. The model assumes that all chemical reaction takes place in thin laminar flamelets which are subjected to strain by the turbulent flow field. The effects of a distribution of strain and possible flamelet extinction on the turbulent burning rate are modeled analytically. The burning rate expression is implemented in an existing turbulent combustion code describing transient combustion in closed vessels, via a development of the Bray-Moss-Libby model, and comparisons are made with previous results obtained using a conventional eddy-break-up rate expression.

47610 Coflowing turbulent jet diffusion flame blowout. Dahm, W.J.A. (Univ. of Michigan, Ann Arbor (USA)); Dibble, R.W. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The authors present results from an experimental and theoretical investigation into the blowout mechanism in turbulent diffusion flames. The blowout stability limits of coflowing turbulent jet diffusion flames are formulated in terms of a recently proposed flame stabilization mechanism based on the large scale organization of entrainment and mixing observed in turbulent shear flows. In contrast to the linear similarity scaling of the more commonly studied simple turbulent jet flames, the nonlinear scaling of coflowing turbulent jets allows an essential element of this stabilization mechanism to be investigated. Results show that when the flame stability criterion is evaluated for the last large structure in the flame as is consistent with the underlying physical picture for this stabilization mechanism, a large reduction in the blowout limit is expected for even a small coflow velocity. This phenomenon is experimentally verified and good quantitative agreement is demonstrated with a set of measurements for the blowout limits of such coflowing turbulent jet flames.

47611 Assessment of theories for the behavior and blowout of lifted turbulent jet diffusion flames. Pitts, W.M. (National Bureau of Standards, Gaithersburg, MD (USA)). pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Many competing theories have been published to describe the characteristics and blowout of lifted turbulent jet diffusion flames. The assumptions which are made as to the physical processes responsible for these behaviors vary widely. In this paper these assumptions are summarized for each model and compared with the actual turbulent behaviors of unignited fuel jets. As part of this discussion, recent unpublished measurements of real-time concentration fluctuations along a line in a turbulent fuel jet are introduced. To the extent possible, each theory is also assessed as to its capabilities to accurately predict experimentally observed lift off and blowout behaviors. The conclusion of these analyses is that none of the currently-available theories for flame stabilization are satisfactory. Further experimentation is required before the actual physical processes responsible for flame stabilization can be identified and models which are capable of accurate prediction of lift off heights and blowout velocities developed.

47612 Lifted turbulent jet flames: A stability criterion based on the jet large-scale structure. Miake-Lye, R.C. (California Institute of Technology, Pasadena (USA)); Hammer, J.A. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A model has been developed to predict liftoff heights of turbulent jet flames. This model is based on the large-scale dynamics of the jet flow field and results in a linear relation between liftoff height and jet exit velocity, a relation that has been observed experimentally in prior studies. The parameterization of the liftoff height relation suggested a series of diluted fuel liftoff experiments which were carried out to further test the model. For small dilutions, good agreement between liftoff data and the model's predictions was obtained. For larger dilutions, a systematic deviation from the model was observed, which is not completely understood. The experimentally observed fluctuations in the liftoff height, in conjunction with the agreement achieved with the present model, provide strong evidence that large-scale dynamics determine the stabilization condition in turbulent jet flames.

47613 Lift-off heights in underexpanded natural gas jet flames. Birch, A.D. (British Gas, West Midlands (England)); Hargrave, G.K. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

This paper describes an experimental investigation into the lift-off heights of flames stabilized in both subsonic and highly underexpanded natural gas jets. The results for the subsonic natural gas jet flames are compared with existing empirical correlations, where the lift-off height is given as a linear function of exit velocity. The present paper extends these correlations to orifice diameters in excess of 100 mm, and shows that no underlying scale effects are present. Flame lift-off heights in super-critical (chocked and underexpanded) jet flames are also presented, and it is shown that the height to the flame stabilization zone achieves a maximum value at high pressure. This behavior is shown to be predicted by existing pseudo-source models which attempt to account for the underexpanded nature of the release. However, the approach is shown to be only partially valid since the limiting lift-off height also exhibits a diameter dependence.

47614 Structural characteristics of lifted turbulent-jet flames. Schefer, R.W. (Sandia National Laboratories, Livermore, CA (USA)); Namazian, M.; Kelly, J. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Instantaneous planar images of the CH_4 concentration in a lifted turbulent-jet flame were obtained by collecting Raman-scattered light perpendicular to a thin sheet of laser light passing through the axis of the flame. The instantaneous images were averaged to obtain mean and fluctuating statistics and probability distributions of the CH_4 concentration. The time-resolved planar images reveal flow and mixing structure information that is lost when time-averaged point measurement techniques are used. Spatial variations in the time-averaged statistics and the effects of combustion on these quantities are interpreted in terms of structural characteristics of these flows. Based on the instantaneous images, two sources of turbulent fluctuations are identified: (1) large-scale movement of the interface separating unmixed fuel and air; and (2) smaller scale turbulent fluctuations that are superimposed on the large-scale jet structure. Combustion heat release is found to have a significant effect on both the turbulence and mixing characteristics of these flows. The primary differences between a lifted flame and a nonreacting jet are a lower centerline decay rate of CH_4, higher instantaneous gradients, and higher concentration fluctuations in the lifted flame. It is shown that the lower centerline decay rate of the CH_4 concentration is due to the reduced mass entrainment rate of the central-fuel jet in the lifted flame. The higher rms fluctuations of CH_4 in the flame are due to the combined effects of: (1) the generally higher CH_4 concentrations along the centerline; (2) the steeper instantaneous CH_4 gradients along the central jet boundaries; and (3) the larger turbulence scales in the mixing region.

47615 Toward a quantitative understanding of elementary combustion reactions. Troe, J. (Universitaet Goettingen (West Germany)). pp. 2072 of Twenty-second symposium (international)

on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

First, unimolecular reactions and recombination reactions are considered. In particular, the implementation of nonthermal determinations of collisional energy transfer properties, of selected excited state rate constants, and of reaction product identifications are described. The relation between potential energy surfaces and high pressure unimolecular bond fissions or radical recombination reactions is analyzed in terms of explicit statistical adiabatic channel calculations. It follows a detailed analysis of more complex bimolecular reactions, treated in the framework of statistical unimolecular rate theory. Particular emphasis is given to the reaction $H + O_2 \rightleftharpoons HO + O$ which passes through an HO_2 intermediate. After the loose entrance-loose exit system HO_2, the reaction $H + HCO \rightleftharpoons H_2 + CO$, passing through an H_2CO intermediate, is chosen as an example for loose entrance-rigid exit systems. Rotational effects, in particular rotational channel switching, are of great importance. The additional effects of collisions on complex-forming bimolecular reactions are modeled in detail. The relationship to the reverse multichannel unimolecular dissociation reactions for the corresponding complex molecule is illustrated. The theoretical methods described provide simple possibilities for a sensitivity test of the rate calculations with respect to the various molecular contributions in a rate coefficient. In this sense they complement sensitivity tests of the modeled mechanisms with respect to the various elementary reactions and their rate parameters. 92 refs.

47616 A kinetic study of ethylene oxidation in a well-stirred reactor. Westbrook, C.K. (Lawrence Livermore National Laboratory, CA (USA)); Thornton, M.M.; Pitz, W.J.; Malte, P.C. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). DOE Contract W-7405-ENG-48. From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Experimental results for the oxidation of ethylene in a well-stirred reactor are examined, and the results are analyzed using a numerical model with a detailed chemical kinetic reaction mechanism. Temperatures studied range from 1003 K to 1253 K, at atmospheric pressure and fuel/air equivalence ratio 0.36 to 0.48. The major reactions consuming ethylene are H-atom abstraction by OH radicals and O atoms, and the computed results provide confirmation for the rate determined very recently by Tully for the reaction $C_2H_4 + OH = C_2H_3 + H_2O$ $k_1 = 2.00 \times 10^{13}$ exp(-5955/RT), which is lower than rate expressions used previously in the literature by a factor of about 10 over the temperature range studied. Comparisons between computed and experimental results show good agreement at temperatures up to about 1200 K. However, at higher temperatures, computed rates of ethylene conversion are much higher than those measured. In the range 1200-1250 K the model predicts effectively complete consumption of the fuel within the given residence time, while the experiments indicate incomplete consumption. These trends, observed previously for n-pentane oxidation in the same well-stirred reactor, are discussed in terms of turbulent mixing and the effects of fluctuations on the rate of fuel consumption in the reactor.

47617 Kinetic study of 1-butene oxidation in a jet-stirred flow reactor. Chakir, A. (Centre de Recherches sur la Chimie de la Combustion et des Hautes Temperatures, Orleans (France)); Cathonnet, M.; Boettner, J.C.; Gaillard, F. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

An analytical study of the oxidation of 1-butene in a jet-stirred flow reactor is presented. The experiments were conducted in the temperature range 900-1200 K at pressures extending from 1 to 10 atm for a wide range of fuel-oxygen equivalence ratios (0.15 to 4.0). The concentrations of molecular species were measured at different extents of reaction by gas chromatography. The main hydrocarbon intermediates were ethylene, propene, methane, 1-3 butadiene and ethane. Several other unsaturated hydrocarbons were also detected as minor products, among them cis and trans 2-butenes. A chemical kinetic reaction mechanism developed previously and extended to reproduce the experimental data is detailed, and the main reaction sequences are discussed. However, several aspects of the mechanism remain not well characterized. Among them, the reactions consuming 1-butene are essential for the development of the reaction process. The presence of 1,3-butadiene in significant concentration is an interesting observation of the present experimental study. Although it is formed for a large part by reaction $C_2H_4 + C_2H_3 = C_4H_6 + H$ the contribution of C_4H_7 reactions is important. This means that H abstraction from 1-butene is a major process removing this compound. However, addition reactions to the double bond are also invocated, and the importance of these processes is not elucidated.

47618 Reactions of HO_2 radicals in combustion chemistry. Walker, R.W. (Hull Univ. (England)). pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Recent attempts to model alkane oxidation with comprehensive mechanisms have shown that HO_2/H_2O_2 chemistry is very important in determining auto-ignition behavior between 600 and 1100 K, particularly as the pressure is raised above 1 atmosphere. Unfortunately, unlike the situation with OH radical reactions, very few kinetic data exist for reactions of HO_2 radicals at combustion temperatures. For this reason, recent experimentally determined rate constants for the following reactions are presented in this paper: (B) $HO_2 + RH \rightarrow H_2O_2 + R$; and (C) $HO_2 + = C = C = \rightarrow = COC = + OH$. Accurate Arrhenius parameters are available for $HO_2 + C_2H_6$ and for HO_2 + tetramethylbutane, and single temperature rate constants have been obtained for HO_2 attack on methane, isobutane and 2,3-dimethylbutane. Reaction (C) is an important route for the conversion of HO_2 radicals into OH, and Arrhenius parameters are available for a number of alkenes. Most of the kinetic data for Rxns (B) and (C) have been obtained by use of the decomposition of tetramethylbutane in the presence of O_2 as a novel source of HO_2 over the temperature range 650-800 K. The system is discussed in outline in the paper. The reaction $HO_2 + HO_2 \rightarrow H_2O_2 + O_2$ plays a key role in determining ignition delay times at higher pressures between 600 and 1000 K, and is also used as a reference reaction in the tetramethylbutane decomposition studies.

47619 A detailed chemical kinetic reaction mechanism for the oxidation of iso-octane and n-heptane over an extended temperature range and its application to analysis of engine knock. Westbrook, C.K. (Lawrence Livermore National Laboratory, CA (USA)); Warnatz, J.; Pitz, W.J. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). DOE Contract W-7405-ENG-48. From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A detailed chemical kinetic reaction mechanism is developed to describe the oxidation of n-heptane, iso-octane, and their mixtures over a wide range of operating conditions. In addition to a high temperature submechanism, reaction paths are included to describe the lower temperature regimes in which the rate and intermediate products of oxidation are controlled by addition of molecular oxygen to alkyl and isomerized alkylperoxy radicals, internal H atom abstractions, and reactions involving O-heterocyclic species. This overall reaction mechanism is validated through comparisons between computed results and experimental data from shock tubes, turbulent flow reactor, and low temperature static and stirred reactors. The mechanism is then used to study the influence of fuel composition on knocking in internal combustion engines. Autoignition of mixtures of iso-octane and n-heptane is examined, in which experimentally measured variations of engine pressure with time were used to simulate the conditions encountered by the end-gases responsible for knocking operation. The computations reproduce the variations of autoignition delay time with octane number and these variations are interpreted in terms of detailed differences in the structure of the two primary reference fuels. Sensitivity analyses of the computations are presented, indicating those portions of the reaction mechanisms which have the greatest influence on the model results.

47620 Promoted high-temperature reactions. Borisov, A.A. (Institute of Chemical Physics, Moscow (USSR)); Zamanskii, V.M.;

Lisyanskii, V.V.; Skachkov, G.K.; Troshin, K.Ya. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

An effect of promoting agents on ignition of various systems is analyzed analytically, numerically and experimentally. For systems with straight chains analytical expressions are derived for the ignition delay as a function of the radical production rate in reactions involving promoter added and for the optimal rate constant of this radical production reaction. An eight-step scheme is suggested for high-temperature self-ignition of hydrocarbons that with the chosen magnitudes of the effective rate constants of the chain propagation and branching steps describes ignition of CH_4-O_2 mixtures in a wide range of initial conditions. This scheme supplemented with reactions involving promoter molecules allowed quantitative estimation of the effect of promoters of different types as a function of temperature, promoter consumption rate, and additive concentration. Calculations agree fairly well with the experimental data. The approach proposed permits predicting promoter efficiency using known kinetic parameters and also selecting promoters with a required efficiency.

47621 Photolytic perturbation method to investigate the kinetics of hydrocarbon oxidation near 800 K. Morley, C. (Shell Research Ltd., Chester (England)). pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A new experimental method has been employed to investigate the chemistry, which leads to autoignition in heptane/air mixtures. A flat cool flame and sometimes a second stage of ignition were stabilized in an electrically preheated flowing gas at atmospheric pressure. The system was essentially one-dimensional, adiabatic and free from surfaces, and so suitable for chemical investigation. The OH radical was detected in the cool flame by laser fluorescence, but except at very low laser intensities the signal was dominated by photochemically produced OH. The precursor was shown to be hydrogen peroxide. By using a high powered pulsed laser to photolytically produce OH in the post cool flame region and a low powered laser to monitor its concentration at later times, a complex decay consisting of 3 exponential curves was observed. This is interpreted in terms of the degenerately branched chain reactions by which the hydrocarbon oxidizes under these conditions and the propagation, termination, branching and branching agent decomposition rates can all be independently measured. The results are shown to broadly consistent with current generalized kinetic models of low temperature hydrocarbon oxidation and the method will find application in providing detailed kinetic data for validating such models.

47622 Chemical kinetic modeling and sensitivity analyses for boron assisted hydrocarbon combustion. Yetter, R.A. (Princeton Univ., NJ (USA)); Cho, S.Y.; Rabitz, H.; Dryer, F.L.; Brown, R.C.; Kolb, C.E. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

As part of a program to systematically investigate the high temperature combustion of particulate boron/liquid hydrocarbon slurries, a kinetic model of homogeneous combustion chemistry for B/O/H/C systems has been developed. The model includes gradient sensitivity analysis procedures to facilitate characterization of reaction mechanisms and to help identify critical thermochemical and kinetic parameters for further theoretical and/or experimental evaluation. The reaction model includes 19 chemical species and 59 forward and reverse elementary reactions. When possible, reaction rate constants and mechanisms were chosen from an evaluation of published experimental data. However, most boron species reaction mechanisms and rate parameters had to be estimated from data for analogous species or from transition state theory. This paper presents model results and sensitivity analyses for adiabatic homogeneous combustion of atmospheric and 8 atm pressure B/O/H/C systems over the temperature range 1800 K < T < 3000 K. Coupled with previous work on isothermal B/O/H/C reacting systems, this work identifies a number of specific reaction mechanisms which require more thorough thermochemical and kinetic characterization.

47623 Understanding complex chemical kinetics with computational singular perturbation. Lam, S.H. (Princeton Univ., NJ (USA)); Goussis, D.A. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A moderately complex hydrogen-oxygen reaction system is used to demonstrate the application of the Computational Singular Perturbation (CSP) technique. Most of the insights normally claimed by theoreticians after a successful convenient singular perturbation analysis on tractable problems can be obtained for highly complex problems using data generated by CSP, including simplified multi-step reaction models. The basic idea of CSP is that the large number of physically meaningful elementary reactions in a complex reaction system can be grouped into separate reaction groups each identified with a single characteristic time scale. CSP theory provides an exact algorithm for the determination of this grouping and the reaction rates of each of the groups, requiring no experience or intuition about the reaction system from the investigator. Sample calculations are performed for the hydrogen-oxygen reaction system at 1600 K and low pressure CSP. Examination of the CSP data suggests that, when [H], [O], [OH], [H_2O], and [HO_2] are present initially only in trace amounts, the reaction system can be represented reasonably accurately by a single set of 5 reaction groups (two extremely fast, two moderately fast, and one extremely slow) over an extended time period. Depending on the interest of the investigator, different simplified multi-step reaction models can be derived to represent the full kinetics formulation.

47624 Tabulation of rate constants for combustion modeling. Steward, P.H. (SRI International, Menlo Park, CA (USA)); Rothem, T.; Golden, D.M. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Extrapolation of rate constant data to temperatures and pressures far from the original experimental conditions is common in combustion modeling. However, great care must be taken when performing such an extrapolation in order to prevent gross errors. Modelers should be able to consult tables of parameters for combustion-relevant reactions that would enable the calculation of rate constants as a function of temperature and pressure over the entire range of interest. A complete tabulation would include both uni- and bimolecular reactions, including those bimolecular reactions proceeding via a bound intermediate. In this paper the authors illustrate the usefulness of such an approach for the H-atom abstraction reactions from ethane and neopentane by O-atoms, OH-radicals and CH_3-radicals and for the more complex reactions $CH_4 = CH_3 + H$, $OH + CO = CO_2 + H$ and $CH_3 + CH_3 = C_2H_5 + H$.

47625 Kinetics of the reactions of unsaturated free radicals (methylvinyl and i-C_4H_3) with molecular oxygen. Slagle, I.R. (Illinois Institute of Technology, Chicago (USA)); Bernhardt, J.R.; Gutman, D. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). DOE Contract FG02-87ER13733. From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The kinetics and mechanisms of the reactions of two unsaturated hydrocarbon free radicals, methylvinyl ($CH_3CH{=}CH$) and i-C_4H_3 ($CH_2{=}C{=}C{-}CH$) with molecular oxygen were investigated using a tubular reaction coupled to a photoionization mass spectrometer. Rate constants were measured as a function of temperature and density in time-resolved experiments. Searches were conducted for possible products to identify reactive routes. The methylvinyl + O_2 reaction was studied between 296 and 600 K. The rate constant is essentially constant throughout this range, $7.2(\pm1.4) \times 10^{-12}$ cm^3 $molecule^{-1}$ s^{-1}. The only reactive route observed is that which yields CH_3CHO and HCO, a route analogous to that of the C_2H_3 + O_2 reaction. The i-C_4H_3 + O_2 reaction rate constant was measured from 296 to 900 K and was found to decrease sharply with increasing temperature, from $4.5(\pm0.9) \times 10^{-12}$ cm^3 $molecule^{-1}$ s^{-1} at 296 to $6.4(\pm1.3) \times 10^{-13}$ cm^3 $molecule^{-1}$ s^{-1} at 900 K corresponding to a $T^{-1.8}$ power dependence in this temperature range. The reaction rate constants of both reactions studied did not depend on density. No products of the i-C_4H_3 + O_2 reaction could be

detected. Possible mechanisms of this reaction are discussed. The role of elementary reactions between unsaturated free radicals and molecular oxygen in combustion processes is briefly reviewed.

47626 Reactions of hydroxymethyl and hydroxyethyl radicals with molecular and atomic oxygen. Grotheer, H.H. (Institut fur Physikalische Chemie der Verbrennung, Stuttgart (West Germany)); Riekert, G.; Walter, D.; Just, T. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Among the elementary reactions forming the methanol and ethanol oxidation subsystem, the reactions of hydroxyalkyl radicals with O_2 are very important. Therefore direct discharge flow reactor measurements for $CH_2OH + O_2$ Rxn. (1M) and $CH_3CHOH + O_2$ Rxn. (1E) were carried out in the temperature range between 300 and 682 K at pressures around 1 mb. Radical profiles were obtained by monitoring the CH_2OH and CH_3CHOH radicals with a low electron energy mass spectrometer. The measured rate coefficients were corrected for kinetic interferences. Both reactions exhibit a strong non-Arrhenius behavior. For 300 { <=} T { <=} 682 K the rate coefficients can be fitted by the analytical expressions: $k_{1M} = 2.5 \times 10^{-9}T^{-1} + 4.0 \times 10^{-10} \exp(-2525/T)$ cm^3/s, $k_{1E} = 1.4 \times 10^{-8}T^{-1.2} + 8.0 \times 10^{-10} \exp(-2525/T)$ cam^3/s. Within the experimental accuracy no kinetic isotope effect for $CH_2OH/CH_2OD + O_2$ and $CH_3CHOH/CH_3CHOD + O_2$ was found. As a function of the ionization energy of the radical, the room temperature rate coefficients for both reactions fit the general data for alkyl + O_2 reactions. The reactions $CH_2OH + O$, Rxn. (2M) and $CH_3CHOH + O$, Rxn. (2E) have been measured directly for the first time. After application of kinetic corrections the result is $k_{2M} = (1.5 \pm 0.5) \times 10^{-10}$ cm^3/s for ($CH_2OH_{2M} + O$) and $k_{2E} = (1.5 \pm 0.5) \times 10^{-10}$ cm^3/s for (2E) ($CH_3CHOH + O$) at ambient temperature. 50 refs.

47627 Direct measurements of methoxy removal rate constants for collisions with CH_4, Ar, N_2, Xe, and CF_4 in the temperature range 673-973 K. Wantuck, P.J. (Los Alamos National Laboratory, NM (USA)); Oldenborg, R.C.; Baughcum, S.L.; Winn, K.R. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Removal rate constants for CH_3O by CH_4, Ar, N_2, Xe, and CF_4 were measured over a 300 K temperature range using a laser photolysis/laser-induced fluorescence technique. Rapid methoxy removal rates are observed for the non-reactive collision partners (Ar, N_2, Xe, and CF_4) at elevated temperatures showing that the dissociation and isomerization channels for CH_3O are indeed important. The total removal rate constant (reaction + dissociation and/or isomerization) for CH_4 follows Arrhenius behavior over the investigated temperature range and is well represented by the form. $k_r = (1.2 \pm 0.7) \times 10^{-8} \exp[(-10170 \pm 350)/T]$ cm^3 $molecule^{-1}$ s^{-1}. Using an RRKM formalism to scale the removal rate constants for the non-reactive collision partners, the dissociation/isomerization portion of the total $CH_3O + CH_4$ removal rate constant has been estimated. Subtracting this estimate from the total removal rate constant yields a $CH_3O + CH_4$ reaction rate constant equal to $k_1 = (2.2 \pm 2.0) \times 10^{-10} \exp[(-7585 \pm 466)/T]$ cm^3 $molecule^{-1}s^{-1}$.

47628 Theoretical study of the reactions rates of OH + OH $\Longleftrightarrow$ H_2O + O. Harding, L.B. (Argonne National Laboratory, IL (USA)); Wagner, A.F. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). DOE Contract W-31-109-ENG-38. From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The rate constants for the forward and reverse reaction of OH + OH to form $H_2O + O$ are calculated with variational transition state theory using an ab initio MCSCF electronic structure characterization of the reaction path on the two potential energy surfaces that correlate reactants with products. With the scaling of the potential barrier so as to match experiment at room temperature, excellent agreement with experiment for the forward direction is obtained over the full temperature range, including a sharp upward curvature above 1000 K. The excited state surface is shown to be important in this curvature, contributing over 35% of the rate constant at higher temperatures. For the reverse direction, it is argued that the $H_2O + O$ measured rates are about a factor or two too large, although this difference could be largely accounted for by uncertainty in the equilibrium constant. The calculated rate constants can be represented by the functional forms: $k_1(T) = 2.04 \times 10^{-20}T^{2.62}e^{944.9/T}$ cm^3/molec-sec, and $k_{-1}(T) = 2.46 \times 10^{-19}T^{2.60}e^{-7636/T}cm^3$/molec-sec over the temperature range of 300 K to 2000 K.

47629 Mechanism and rate constants for the reactions of hydrogen atoms with isobutene at high temperatures. Tsang, W. (National Bureau of Standards, Gaithersburg, MD (USA)); Walker, J.A. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Hydrogen atoms from the thermal decomposition of 2,3,3 trimethylbutanol-2 have been used to induce the decomposition of isobutene in single pulse shock tube experiments. The authors have been able to observe products arising from all of the high temperature reaction channels for hydrogen attack on isobutene. The following rate expressions have been determined. k(H + isobutene → propylene + CH_3) = $1.72 \times 10^{10}\exp(-1808/T)$ 1/mol-s and k(H + isobutene → 2-methyl-2-allyl + H_2) = $1.72 \times 10^{11}\exp(-4024/T)$ 1/mol-s in the temperature range of 1000-1180 K and at 2.5-3 atmospheres pressure. The rate constants for the abstraction of vinylic hydrogens are not more than 8% of that for abstraction of the allylic hydrogens. Comparisons are made with rate constants of similar processes involving branched aromatics and lower temperature results on isobutene. Interesting correlations are observed and lead to the possibility of estimating rate expressions for reactions involving other olefins.

47630 Reactions of vinyl and phenyl radicals with ethyne, ethene and benzene. Fahr, A. (National Bureau of Standards, Gaithersburg, MD (USA)); Stein, S.E. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Rates of vinylation and phenylation of ethyne, ethene and benzene have been determined relative to vinyl recombination in a Knudsen cell flow reactor. Phenylvinylsulfone and divinylmercury were used as radical initiators and studies were done over the temperature range 1000-1330 K. Assuming a recombination rate constant of $10^{10.3}$ $M^{-1}s^{-1}$ for vinyl and $10^{9.5}$ for phenyl, the authors obtain the following rate constants ($M^{-1}s^{-1}$) at 1100 K: k(R = vinyl) k(R = phenyl) R. + C_2H_2 → R-C_2H + H. $2.0 \pm .4 \times 10^8$ $2.6 \pm .6 \times 10^8$, R. + C_2H_4 → R-C_2H_3 + H. $1.4 \pm .2 \times 10^8$ $1.5 \pm .4 \times 10^8$, R. + C_6H_6 → R-C_6H_5 + H. $4.5 \pm 1.2 \times 10^7$ $6.0 \pm 2.0 \times 10^7$. When combined with room temperature addition rates from the literature, the authors obtain ($M^{-1}x^{-1}$): k(vinyl + ethyne → vinylacetylene + H) = $10^{9.3}$ exp(-5.0 kcal/RT), k(phenyl + benzene → biphenyl + H) = $10^{8.6}$ exp(-4.0 kcal/RT).

47631 A theoretical analysis of the reaction between hydroxyl and acetylene. Miller, J.A. (Sandia National Laboratories, Livermore, CA (USA)); Melius, C.F. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Using BAC-MP4 potential-surface parameters and statistical-theoretical methods, the authors have calculated thermal rate coefficients for the reactions, (a) OH + C_2H_2 → C_2H + H_2O; (b) OH + C_2H_2 → HOC_2H + H; (c) OH + C_2H_2 → CH_2CO + H; (d) OH + C_2H_2 → CH_3 + CO; and the high-pressure limit of the addition reaction (k) OH + C_2H_2 → C_2H_2OH. For pressures low enough that collisional stabilization is negligible, the authors find that reactions (a) and (b) dominate at temperature, whereas reaction (c) prevails at low temperature, although $K_c < 10^{-3}$ k at low T. The theoretical results are used to interpret and to discuss the experimental data available. Modified Arrhenius rate expressions are provided for k_a, k_b, k_c, k_d, and k.

47632 The reactions of benzyl radicals with hydrogen atoms, oxygen atoms, and molecular oxygen using EI/REMPI mass spectrometry. Bartels, M. (Universitaet Goettingen (West Germany)); Edelbuettel-Einhaus, J.; Hoyermann, K. pp. 2072 of

Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The reactions of benzyl radicals (C_7H_7) with H atoms, O atoms and O_2 molecules were studied at low pressures (around 1 mbar) and room temperature in multiple discharge flow reactor arrangements by molecular beam sampling and mass spectrometry. The ionization of labile and stable species was performed using electron impact ionization (EI) and resonance enhanced multiphoton ionization (REMPI) by an excimer pumped dye laser arrangement. The C_7H_7 radicals were produced by the reactions of toluene (C_7H_8) with halogen atoms. Relative rate constants were measured with reference to the reaction $CH_3 + D \rightarrow CH_2D + H$ leading to $k_3 = 3.3\ 10^{14}$ cm^3/mol s and $k_{3D} = 1.8\ 10^{14}$ cm^3/mol s. The rate of the reaction $C_7H_7 + O_2 \rightarrow$ products under the low pressure and temperature conditions was estimated to be k { >=} 3 10^{11} cm^3/mol s. 38 refs.

47633 A shock tube study on the thermal decomposition of toluene and of the phenyl radical at high temperatures. Braun-Unkhoff, M. (Institut fuer Physikalische Chemie der Verbrennung, Stuttgart (West Germany)); Frank, P.; Just, T. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The thermal decomposition of toluene molecules and of phenyl radicals have been investigated behind reflected shock waves by monitoring the formation of hydrogen atoms with ARAS. The temperatures ranged between 1300 and 1800 K at total pressures between 1.5 and 7.8 bar. Nitrosobenzene C_6H_5NO served as a thermal source for the phenyl radicals. The test gas mixtures consisted of argon with relative concentrations of 2 to 30 ppm toluene and of 1 to 100 ppm nitrosobenzene, respectively. Due to the low initial concentrations of toluene and nitrosobenzene it was possible to evaluate first order rate coefficients for the initiation reactions and for some fast follow-up reactions in the phenyl pyrolysis subsystem. From a least squares analysis of all measured points the following rate expressions are deduced: $k_1 = 3.6 \times 10^{15} \exp(-(45000 \pm 1800)/T) s^{-1}$ for $C_7H_8 \rightarrow C_7H_7 + H$, 1380 { <=} T { <=} 1700 K and $\rho = 1.1 - 6.8 \times 10^{-5}$ mol cm^{-3}; $k_4 = (4.5 \pm 1.2) \times 10^{13} \exp(-(36500 \pm 1325)/T)\ s^{-1}$ for the intramolecular rearrangement of phenyl to linear C_6H_5: $C_6H_5 \rightarrow$ l-C_6H_5 1450 { <=} T { <=} 1730 K and $\rho = 1.0 - 1.7 \times 10^{-5}$ mol cm^{-3}, which is followed by very fast unimolecular decomposition of the linear intermediate to $C_4H_3 + C_2H_2$ and $C_6H_4 + H$.

47634 Benzene oxidation perturbed by NO_2 addition. Lovell, A.B. (Princeton Univ., NJ (USA)); Brezinsky, K.; Glassman, I. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

By altering the O, H and OH radical concentrations through the addition of NO_2 to benzene oxidation studies in a flow reactor, it has been shown that the predominate route to the formation of the important intermediate phenoxy radical is by the reaction of phenyl with O_2. These studies have also shown that O atom addition to benzene to form phenol which then reacts with radicals is not an important route to the formation of phenoxy. Further, the fate of the cyclopentadienyl radical, another important intermediate, has been shown to be determined not by reactions with O_2, but with members of the OH, H and O radical pool.

47635 On the driving force of PAH (polycyclic aromatic hydrocarbons) production. Frenklach, M. (Pennsylvania State Univ., University Park (USA)). pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A theoretical analysis of the kinetic factors affecting the production rate of polycyclic aromatic hydrocarbons in high-temperature pyrolysis and combustion environments is presented. The analysis is based on a lumped kinetic model, representing polymerization-type growth by one irreversible and two reversible steps, which underlies the H-abstraction/C_2H_2-addition reaction mechanism identified in previous detailed kinetic studies. The analytical solution obtained for the steady-state assumption indicates that PAH production is not determined by a single parameter; several variables influence the process to different degrees depending on experimental conditions. At high temperatures, PAH growth is controlled by the superequilibrium of hydrogen atoms. At low temperatures and low H_2 concentrations, the PAH growth rate is proportional to the rate of the H-abstraction of a hydrogen atom from aromatic molecules; at low temperatures and high H_2 concentrations, it is controlled by the thermodynamics of the H-abstraction and the kinetics of acetylene addition to aromatic radicals. The presence of oxygen mainly affects the small-molecule reactions during the induction period.

47636 High temperature rate coefficient for the reaction CN + O_2 → NCO + O using different CN-sources. Burmeister, M. (Universitaet Duisburg (West Germany)); Gulati, S.K.; Nataranjan, K.; Thielen, K.; Mozzhukin, E.; Roth, P. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The reaction of CN radicals with oxygen has been studied behind reflected shock waves using two different thermal sources of CN radicals, viz. C_2N_2 and BrCN. Mixtures of C_2N_2/, O_2 and BrCN/O_2 highly diluted in argon were heated by reflected shock waves and the concentrations of N and O atoms were monitored in the post shock reaction zone by using the Atomic Resonance Absorption spectroscopy (ARAS). From both, C_2N_2/O_2 and BrCN/O_2 experiments, a mean rate coefficient for the reaction: $CN + O_2 \rightarrow NCO + O$ $k_2 = 7.0 \times 10_{12}$ cm^3 mol^{-1} s^{-1} could be determined by computing directly from the measured N and O atom concentrations. The experiments for C_2N_2/O_2 and BrCN/O_2 mixtures were conducted in the temperature range 2160-2750 K and 1928-3100 K at pressures of about 1.7-2.0 bar and 3.30-4.30 bar, respectively. The present rate coefficient data is compared with the results obtained earlier in this laboratory by using HCN as a source of CN radicals.

47637 Measurements of absolute rate coefficients for the reactions of CN radicals with H_2O, H_2, and CO_2 in the temperature range 295 K ≤ T ≤ 1027 K. Jacobs, A. (Universitaet Heidelberg (West Germany)); Wahl, M.; Weller, R.; Wolfrum, J. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Absolute rate coefficients were measured at different temperatures by means of laser photolysis-laser induced fluorescence technique for the reactions: (1) $CN + H_2O \rightarrow HCN + OH$; (2) $CN + H_2 \rightarrow HCN + N$; (3) $CN + CO_2 \rightarrow$; OCN + CO. The temperature dependent rate coefficients for reactions (1) and (2) could be fit by Arrhenius expressions and are: k_1 (518-1017 K) = $(8.0 \pm 0.8) \times 10^{12}$ exp [-(31.2 ± 0.6) kJ/RT] cm^3 mol^{-1} s^{-1}, and k_2 (295-1000 K) = $(2.1 \pm 0.2) \times 10^{13}$ exp [-(19.7 ± 0.5) kJ/RT] cm^3 mol^{-1} s^{-1}. For thermodynamical properties of Rxn. (1) the authors evaluated the temperature dependent rate coefficient for the reverse reaction: $k_{-1} = (7.7 \pm 1) \times 10^{12}$ exp [-(34.6 ± 1) kJ/RT] cm^3 mol^{-1} s^{-1}. In the CN + CO_2 system they did not observe CN 1st order rate constants attributable to chemical reaction at temperatures up to 1000 K. The authors estimated an upper limit for k_3 of 2.5×10^9 cm^3 mol^{-1} s^{-1}. The experimental results are compared with literature data. In the case of Rxn. (1) and (2) the agreement with previous experimental and theoretical studies is good, whereas the results for k_3 are strongly different from former measurements.

47638 Free-radical oxidation of isocyanic acid. Tully, F.P. (Sandia National Laboratories, Livermore, CA (USA)); Perry, R.A.; Thorne, L.R.; Allendorf, M.D. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Laser-based kinetic studies of the reactions OH + HNCO → Products (1) and $O(^3P)$ + HNCO → Products (2) are described. Deuteration of isocyanic acid demonstrates that hydrogen-atom abstraction is an important channel for reaction (1). The kinetic results may be represented by the Arrhenius expressions $k_1(T) = (4.4 \pm 0.9) \times 10^{-12}$ exp [-(5.54 ± .28) kcal mol^{-1}/RT] cm^3 $molecule^{-1}$ s^{-1} and $k_2(T) = 5.4 \times 10^{-12}$ exp [-10.3 kcal mol^{-1}/RT] cm^3

molecule^{-1} s^{-1}. The mechanistic implications of these results on the RAPRENO$_x$ process are discussed.

47639 Detailed kinetic studies on elementary NH_2-reactions. Baetz, P. (Max-Planck-Institut fur Stroemungsforschung, Goettingen (West Germany)); Ehbrecht, J.; Hack, W.; Rouveirolles, P.; Wagner, H.G. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The $NH_2(X^2B_1)$ reactions: $NH_2 + D_2 \rightarrow NH_2D + D$ (R1), $NH_2 + H_2O \rightarrow NH_3 + OH$ (R2) and the reverse reaction: $OH + NH_3 \rightarrow NH_2 + H_2O$ (R3) have been measured directly in an isothermal discharge flow system at pressures in the range $1.3 \leq p/m\ bar \leq 4.0$ with He as the main carrier gas. NH_2 and OH were produced in the reaction of F atoms with NH_3 and H_2O respectively. Laser induced fluorescence (LIF) detection was used to follow the OH and NH_2 radical concentrations as a function of the position of movable probes. For Rxn. (R1) kinetic data were obtained by following the $[NH_2]$ profiles under pseudo first order conditions $[NH_2]_0 < < [D_2]_0$ in the temperature range $639 \leq T/K \{ <=\} 1140$. $k_1(T)$ is represented by the following Arrhenius-expressions: $k_1(T) = 2.9 \cdot 10^{12} \exp(-47.6 \pm 2\ kJ\ mol^{-1}/RT)\ [cm^3\ mol^{-1}\ s^{-1}]$. Direct measurements for the kinetic isotope effect resulted in $k_1(H_2)/k_1(D_2) = 3.3$ at 740 K and 2.4 at 1140 K. Ab initio energy surfaces calculated with the CEPA-method were used to discuss the kinetic isotope effect in comparison to $NH_2 + H_2$ in relation to tunnel corrections. For Rxn. (R2), the rate constant $k_2(1000\ K) = 6 \cdot 10^9\ cm^3\ mol^{-1}$ was obtained experimentally. The comparison with $k_2(T)$, calculated from the reverse reaction at 1000 K, confirmed the value of 192 kJ mol^{-1} for the heat of formation of NH_2.

47640 Laser-fluorescence measurements of nitric oxide in low-pressure H_2/O_2/NO flames. Cattolica, R.J. (Sandia National Laboratories, Livermore, CA (USA)); Cavolowky, J.A.; Mataga, T.G. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The concentration profiles of NO in low-pressure (76 Torr) H_2/O_2/Ar flames to which nitric oxide was added (0.94% and 1.74% in argon), were measured by pulsed, laser-induced fluorescence. Laser excitation of NO in the (1,0) band of the $A^2\Sigma \rightarrow X^2\Pi$ transition at 214.34 nm was followed by detection, either time-integrated or temporally resolved, of the fluorescence in the (1,4) band at 252.2 nm. The temporally resolved fluorescence measurements were used to determine the collisional de-excitation rates needed to convert time-integrated fluorescence signal into nitric oxide concentration. Five flames were studied with H_2/O_2 equivalence ratios of 0.88, 0.98, 1.22, 1.37, and 1.50. In these flames the collisional de-excitation rate decreases rapidly above the burner surface as the density decreases with increasing temperature. A 20% decrease was observed for the lean flames, and a 30% decrease for the rich flames. For the near stoichiometric flame, the measured de-excitation rate constant was used to determine a collision cross section of 38 Å^2 at 1414 K for collisional de-excitation of the $A^2\Sigma$ ($v' = 1$) state (including both electronic quenching and vibrational relaxation) by water. Within the precision of the measurement technique (± 10%), no significant removal of nitric oxide was observed in these flames.

47641 Nitrogen dioxide formation by the mixing of hot combustion gas with cold air. Hori, M. (Univ. of Tokyo (Japan)). pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

NO, NO_2, stable species concentrations and temperature have been measured in a double concentric jet facility to study the mechanism of NO_2 formation by the mixing of hot combustion gases with cold air. The double concentric jets are designed to model the mixing region in practical combustion systems and consist of a central hot combustion gas jet from a propane/air burner and an annular cold air jet confined in a cylindrical duct. The main objective of this study is to determine the effect of equivalence ratio on NO_2 formation. The burner was operated under a wide range of equivalence ratios from 0.62 to 1.60. NO was found to convert to NO_2 in the mixing region of the jets through the HO_2 mechanism (oxidation of NO mainly by HO_2 radical). The degree of NO_2 formation can be quantified from the NO_2/NO_x ratio measured at the exit of the duct. Under fuel-lean conditions, with decreasing the equivalence ratio, the NO_2/NO_x ratio increases up to 0.81 though the total NO_x level quickly decreases. The effect of initial NO level on the NO_2 formation seems to be dominant in this case, which explains higher NO_2/NO_x ratio with lowering the initial NO levels. Under fuel-rich conditions, the NO_2/NO_x ratio is about 0.90 at equivalence ratios above 1.2. The additional supply of radicals from the diffusion flame, and the presence of unburned species in relatively cool regions probably yield the high NO_2/NO_x ratio under the fuel-rich conditions.

47642 Formation of NO_x and burnoff of CO during thermal quenching of the products from combustion in a thermally stabilized burner. Strenger, M.R. (Univ. of Pennsylvania, Philadelphia (USA)); Churchill, S.W. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

In the experimental work, premixed ethane and air were burned in passage through seven 9.5-mm round channels in a ceramic block. In this burner, volumetric rates of heat release due to combustion greater than 2.0×10^8 W/m^3 were achieved. The products of combustion were then passed in series through stainless steel tubes of the same diameter immersed in boiling water. The composition of the gas was determined at a number of locations along one of the cooling tubes. Twenty-one free-radical reactions were used to model the chemical behavior of the gas during this process of cooling. Both the measurements and the computations showed the mole fraction of NO_x to be frozen at the value near the entrance of the cooling tube. The formation of prompt NO_x is negligible in this burner owing to minimal back-mixing. Hence, the total formation of NO_x is proportional to the time of residence between the flame front and the exit of the burner, which can be reduced to as low as 2.0 ms on the mean, resulting in concentrations as low as 10 ppm in the effluent. For lean mixtures the CO was found to continue oxidizing during the process of cooling, leaving, for an equivalence ratio of 0.80, as few as 90 ppm (.009%) in the effluent. Above 0.88, the greater initial amount of CO resulted in its incomplete oxidation during the cooling. Owing to the use of forced convection inside tubes, a very high rate of heat transfer from the burned gas to the boiling water was achieved. Thus, the overall process described herein is very efficient thermally as well as minimally polluting.

47643 Model of the flow assisted spread of flames over a thin charring combustible. Di Blasi, C. (Universita di Napoli (Italy)); Crescitelli, S.; Russo, G.; Fernandez-Pello, A.C. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A theoretical model is developed of the spread of a flame over the surface of a thin combustible solid in a gas flow moving in the direction of flame propagation. The combustion reaction and the solid pyrolysis are modeled respectively with a one-step, second order, and with a zero order Arrhenius rate. The charring of the solid is modeled by treating the solid as a two component material, the combustible component that gasifies, and the char that remains occupying the initial solid volume. The transient, reactive, gas phase balance equations of energy and species coupled at the interface to the solid phase balance equations are solved numerically to describe the evolution of the flame and solid properties, and through them to predict the variation with time of the flame, pyrolysis and burn-out distances and their dependence on the flow velocity. The application of the analysis to the spread of flames over paper sheets in a concurrent air flow gives good agreement with previous experimental data. Particularly important is the description of the transition of the flame spread process from an initial accelerative stage to a final steady state. The transition is determined by the interaction between the progress of the pyrolysis and the burnout fronts, and their effects on the flame length. According to boundary layer analyses, the model predicts a spread rate that first increases at low flow velocities and then becomes constant as the flow velocity is increased. Possible reasons for this disagreement are discussed in the paper.

47644 Near-limit flame spread over a thin solid fuel in microgravity. Olson, S.L. (NASA Lewis Research Center, Cleveland, OH (USA)); Ferkul, P.V.; Tien, J.S. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Diffusion flame spread over a thin solid fuel in quiescent and slowly moving atmospheres is studied in microgravity. The flame behavior is observed to depend strongly on the magnitude of the relative velocity between the flame and the atmosphere. In particular, a low velocity quenching limit is found to exist in low oxygen environments. Using both the microgravity results and previously published data at high opposed-flow velocities, the flame spread behavior is examined over a wide velocity range. A flammability map using molar oxygen percentages and characteristic relative velocities as coordinates is constructed. Trends of flame spread rate are determined and mechanisms for flame extinction are discussed.

47645 Flame propagation for polymers in cylindrical configuration and vertical orientation. Tewarson, A. (Factory Mutual Research Corporation, Norwood, MA (USA)); Khan, M.M. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Experimental results are presented for vertical flame propagation for single and multiple cylinders (electrical cables and solid pine). Experiments for single, 0.508 and 1.29 m long, cylinders were performed in the apparatuses; O_2 concentration in the range of 21 to 45% was used to enhance the flame propagation rate. Experiments for multiple cylinders were performed in the 5 MW-scale apparatus, with two (0.61 m wide and 4.9 m long) sheets of cables facing each other and separated by about 0.31 m. A new technique based on the chemical energy released during flame propagation and extend of flame propagation was used to calculate the flame propagation rate. The flame propagation rate in the 500 kW and 5 MW-scale apparatuses showed good correlation and satisfied the engineering relationships derived from the fundamental flame propagation theories. The following relationship was found for the flame propagation rate: $V^{1/2} = 2.79\ [Q_{ch}/\Pi d^{1/3}/(kpc_p)^{1/2}\Delta T] + 0.0072$. For 0.508 and 1.29 m long cylinders, the effective flame heat transfer distance was estimated to be about 0.16 m. The extent of flame propagation and propagation rate were found to be interrelated. Under the experimental condition, without additional heat flux to enhance the flame heat flux, the extent of flame propagation was estimated to be 100% of the available are for $V \geq 5 \times 10^{-3}$ m/s, and for $V \leq 1 \times 10^{-3}$ m/s, the estimation showed no propagation.

47646 Radiance, soot, and temperature interactions in turbulent alcohol fires. Fischer, S.J. (Washington State Univ., Pullman (USA)); Grosshandler, W.L. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The fires above 0.5 meter pools of isopropanol and ethanol have been studied experimentally to determine the time-averaged composition of radiating gases and soot, the fluctuating temperature distribution functions, and the radiation which leaves the flames. Temperature is determined from a thermocouple rake, permitting correlation of the temperatures at eleven positions along the fire diameter. Digitized time-lapse photographs enhance the understanding of the visible radiation in the fire. In both fires, the peak average temperature is about 1275 K with a standard deviation close to 300 K, and the dominant flickering frequency is near 2 Hz. Significant differences in the fires exist: the thermal output of the isopropanol is 131 kW, double the ethanol fire; the peak radiance from the isopropanol is 17 kW/m^2/sr, also double the ethanol value; the maximum local monochromatic soot extinction coefficient in the isopropanol fire is 7.8 m^{-1}, ten times that of ethanol; and the gray absorption coefficients are calculated to differ by a factor of four in the two fires. Two alternative models are proposed for the soot absorption coefficient: steady-state soot kinetics on the fuel rich side of the flame front coupled with frozen chemistry where the fuel concentration is low, and a model which ties the soot level directly to the carbon monoxide concentration.

47647 Radiative properties of chain-agglomerated soot formed in hydrocarbon diffusion flames. Mackowski, D.W. (Univ. of Kentucky, Lexington (USA)); Altenkirch, R.A.; Menguc, M.P.; Saito, K. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Transmission measurements at five infrared wavelengths were made in acetylene-, 1,3 butadiene-, and ethylene-air diffusion flames to determine if soot formed in these flames exhibits nonspherical, radiative behavior. Soot is modelled radiatively as being composed of a mix of Lorenz, Mie equivalent-spheres and Rayleigh-limit, infinite-length cylinders. The cylindrical particle fraction, φ, determined from experiment is largest in the acetylene flames, increases with increasing height in all flames, and is largely independent of the smoking condition of the flame. Values of φ obtained in the acetylene flames imply a mix of spheres and cylinders that corresponds radiatively to prolate spheroids, with uniform internal electric field, of aspect ratio 4 to 5. Such as aspect ratio is greater than the 2.5 needed to obtain equivalence between prolate spheroids and a long, straight chain of neighboring, Rayleigh-limit, interacting spheres. Because sampled soot particles show aspect ratios greater than 4 to 5, the implications are that the radiative properties of soot agglomerates are between those of prolate spheroids and straight-chain, neighboring spheres.

47648 Effects of turbulence on flame radiation from diffusion flames. Delichatsios, M.A. (Factory Mutual Research Corporation, Norwood, MA (USA)); Orloff, L. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Enhancement of heat transfer by blame radiation in furnaces can increase the efficiency and decrease the volume of a furnace. Flame radiation from turbulent diffusion flames, which prevail in furnaces, depends both on the chemistry of soot formation and the turbulent mixing processes of the flow. Previous work has shown that thermochemical effects (i.e. fuel or air preheating, oxygen enhancement, etc.) related to soot formation chemistry and flame radiation can be correlated in turbulent diffusion flames by using smoke-point properties of laminar diffusion flames. This work addresses the other part of the turbulent flame problem which involves the effects of the turbulent flow field on soot formation and radiation for given fuel and thermochemical conditions. Radiation measurements in turbulent momentum controlled jet flames were made by using five nozzles (1 mm, 1.5 mm, 2 mm, 3 mm, 4 mm) having a large contraction ratio and burning three fuels: acetylene (C_2H_2), propylene (C_3H_6) and methane (CH_4). By employing the relatively well understood flow of a turbulent jet flame, the following fundamental issue was addressed: is soot formation in turbulent diffusion flames determined by the overall residence (macroscale) time or by the straining rate of the small (Kolmogorov) scales wherein combustion occurs? Correlations of the present data obtained by using a simple soot formation and radiation model support the small scale (Kolmogorov) straining rate hypothesis.

47649 Turbulence/radiation interactions in nonpremixed hydrogen/air flames. Kounalakis, M.E. (Univ. of Michigan, Ann Arbor (USA)); Gore, J.P.; Faeth, F.M. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Mean and fluctuating spectral radiation intensities were measured for nonpremixed turbulent hydrogen jet flames burning in still air. Intensities of radiation fluctuations of 20-110 percent were observed, providing direct evidence of turbulence/radiation interactions in these flames. Radiation fluctuations were analyzed using a narrow-band radiation model combined with a stochastic simulation of scalar property variations along the radiation path. There was encouraging agreement between predicted and measured mean and fluctuating values, probability density functions, and temporal power spectral densities of spectral radiation intensities, except for spikes in the spectra associated with the release of coherent structures which become more prominent as effects of buoyancy increase. Similar to

the findings of others, mean radiation levels were generally underestimated by predictions based on mean scalar properties.

47650 On the flame structure at the base of a pool fire. Bouhafid, A. (Universite de Poitiers, St Julien L'Ars (France)); Vantelon, J.P.; Joulain, P.; Fernandez-Pello, A.C. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A detailed mapping is presented of the temperature, CO, CO_2, and O_2 species concentrations, and monochromatic absorption coefficient at the base region of a kerosene pool fire. Comparative analysis of the isotherm and iso-concentration patterns indicates that the buoyant flame has in intermittent character at its base, contrary to its normally attributed persistent, or anchored, character. The temperature field shows a band of temperature maxima that approximately coincides with the luminous flame boundary. The temperature in this band, however, decreases toward the fire axis and is lower than that expected in a kerosene flame. This, in conjunction with the presence of high oxygen concentration in the fuel side of the temperature maxima band, indicates that the flame fluctuates around a mean position, and that as a consequence the measured temperatures are lower averaged values of the fluctuating temperature field. The CO and CO_2 iso-concentration fields show a region of elevated concentrations at the axis near the liquid surface that is displaced toward the fuel side with respect to the temperature maxima region, rather than coinciding with it. The lines of constant absorption coefficient, which can be associated with lines of constant soot concentration, also show a region of elevated values that approximately coincides in location with that of the CO and CO_2 concentrations. From the observed characteristics of the flame structure it can be concluded that the flame at the pool fire base is better described as a fluctuating, laminar, diffusion flame, which later becomes a turbulent, intermittent one as it evolves upward along the fire plume.

47651 The oscillatory behavior of medium-scale pool fires. Weckman, E.J. (Univ. of Waterloo, Ontario (Canada)); Sobiesiak, A. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

This paper describes an investigation of the formation of the large-scale structures which govern air entrainment and mixing in the continuous flame zone of a 30 cm diameter acetone pool fire. Flow visualization was combined with Laser Doppler Anemometer velocity and thermocouple temperature measurements to determine the pulsation frequency of the fire and to identify the regions of the fire involved in the evolution of these structures. The visible fire structure and the pulsation frequency were also examined when the boundary conditions on the burner were varied. The flow visualization studies and the velocity and temperature profiles suggested a detailed description of the stages occurring during the development of large-scale structures in the fire. The frequency of oscillation of the fire varied only slightly with the reduction of fire radiation back to the surface of the fuel and with minor blockages in the entrainment of air at the edges of the fire. When the flow of air into the base of the fire was altered more significantly, the visible structure of the fire and its frequency of oscillation were affected to a larger extend. It appears that the large-scale structures are more a result if instabilities in the fluid dynamics external to the fire, than the variations in flame chemistry due to the local accessibility of fuel and air. An initial phenomenological model of the entrainment processes and their effect on fire behavior formulated as a result of these experiments has provided further insight into the complex processes which interact in the continuous flame zone of a medium-scale pool fire.

47652 Model experiments of ship fire. Takeda, Hisahiro (Univ. of Tokyo (Japan)). pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Ship fire behavior was investigated using a reduced scale enclosure with the ventilation opening in the center of the ceiling in order to establish a reasonable ship fire model. The experiments were carried out using a PMMA sample installed in the center of one wall or the floor in the enclosure. The opening had two major effects on the model ship fire. One is to hinder the development of a hot gas layer. Hot gas released from the flame zone tends to escape the enclosure through the opening without heating the upper part of enclosure. Thus the fire growth was greatly delayed when compared to ordinary compartment fires previously studied. The other effect is poor ventilation. The fire was strongly controlled by poor ventilation, so the burning rate was suppressed at a very low level. After the whole PMMA sample was involved, the flame moved from the PMMA surface to float in the gas phase and turned to a dark blue flame due to poor ventilation. However, the puffing (oscillation) of ventilation was not observed in any opening condition. This was an unexpected result. And the fire was rather steady even under this poor ventilation condition. Probably bi-directional flow could occur in the ventilation opening.

47653 Fire computation: The flashover phenomenon. Lockwood, F.C. (Imperial College, London (England)); Malalasekera, W.M.G. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

This paper describes the application of a predictive code of the field model type to the prediction of compartment fires. The flashover problem, in so far as it is influenced by heat transfer, is given special consideration. This emphasis is facilitated by the refined nature of the method employed to calculate thermal radiation transfer. Data from the test cell of the Lawrence Livermore Laboratories and from that of the Swedish National Testing Institute are deployed in the validation exercises. The latter possess the advantage of having been obtained for a broad spectrum of tests in which the time to flashover was specifically recorded. On the whole, agreement between the predictions and the data is good. However the prediction of the time to flashover is severely hindered by the lack of a suitable model technique for the prediction of flame spread. For those Swedish tests where flashover was not preceded by significant flame spread, the time to flashover is predicted by reference to the critical heat flux. The authors conclude that: (1) the total heat transfer to solid surfaces, a critical factor influencing flashover, is seemingly well predicted by the present code, (2) a flame spread model suitable for incorporation in field model type codes needs to be devised and validated, and (3) that correspondingly specialist flame spread experiments require to be performed to provide the necessary validation data.

47654 Effects of thermal stability and melt viscosity of thermoplastics on piloted ignition. Kashiwagi, T. (National Bureau of Standards, Gaithersburg, MD (USA)); Omori, A. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The effects of material characteristics on piloted ignition were studied by using two different polystyrene, PS, samples and two different poly(methyl methacrylate), PMMA, samples. The difference between the two PS samples was melt viscosity due to two different initial molecular weights and that between the two PMMA samples was thermal stability and melt viscosity also due to two different initial molecular weights. Ignition delay times and time histories of surface temperature and sample weight changes were measured in the external radiant flux range of 0.9-3.0 W/cm^2. A comparison of results between the two PS samples and between the two PMMA samples was made. The comparison indicates that the transport process of indepth degradation products through the molten polymer layer to the sample surface has negligible effects on piloted ignition. However, the thermal stability of the material has significant effects on the piloted ignition delay time and the surface temperature at ignition. The surface temperature at ignition is 260-270 C for the thermally unstable PMMA sample and 320-340 C for the thermally stable PMMA sample. The surface temperatures at ignition of the two PS samples are 350-370 C. The mass flux at ignition for PMMA is 0.06-0.09 x 10^{-3} g/cm^2 s and larger than 0.03-0.05 x 10^{-3} g/cm^2 s for PS.

47655 Flame-jet ignition of large fuel-air clouds. Mackay, D.J. (Defense Research Establishment Suffield, Alberta (Canada)); Murray, S.B.; Moen, I.O.; Thibault, P.A. pp. 2072 of Twenty-second

symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The experimental configuration consisted of a steel tube connected to a large plastic bag simulating an unconfined region. The test volumes were filled with fuel-air mixtures employing acetylene, ethylene, propane and vinyl chloride monomer fuels. Transition to detonation was observed in the bag for acetylene-air mixtures under a variety of geometric conditions. In the case of a flame jet emerging from an open tube, high-speed cinematography and numerical calculations have shown that the entrainment of hot combustion products into the vortex established by the shock-induced flow ahead of the flame is responsible for a sequence of localized explosions which result in shock wave amplification sufficient to initiate detonation. Other modes of transition were observed with the acetylene-air system, including transition downstream of a central blockage, transition due to colliding flame tongues in an asymmetric jet, and transition due to flame/boundary interactions. Data suggest that the critical conditions are established by the flame jet and that nearby perturbing boundaries merely trigger the onset of detonation. Although transition to detonation was not observed with the other fuel-air systems, it was found that a significant explosion in the bag could nonetheless occur for the relatively sensitive ethylene-air system, generating pressures approaching 6 bar. Cinematographic coverage has revealed that this is likely the result of a series of hot spots or regions of high reactivity developing downstream of the tube exit.

47656 Flame propagation along a vented duct containing grids. Taylor, P.H. (Shell Research Ltd., Chester (England)); Bimson, S.J. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A theoretical model has been developed to describe steady flame propagation in pre-mixed fuel-air contained within a partially open duct. The duct contains obstacles in the form of grids to distort the propagating flame front. Both the effects of increasing the number of obstacles in each grid and decreasing the proportion of the roof of the duct opens for venting are predicted by the model and compared to laboratory experiments. Although the model is simple, concentrating on the fluid dynamics of the mean flows generated by the volume production within the flame, it demonstrates how to correlate experimental data for both steady flame propagation in a long duct and also for the initial phase of rapid flame acceleration after ignition. These results constitute further evidence that the physical processes which can lead to vapor cloud explosions in petrochemical plant are dominated by the structure of the underlying fluid mechanics. Thus much of the complex behavior of propagating flames in partially confined and/or congested regions at least at laboratory scale can be explained using simple but nonlinear fluid mechanics models.

47657 Initiation and suppression of combustion instabilities by active control. Poinsot, T. (Ecole Centrale des Arts et Manufactures et CNRS, Chatenay-Malabry (France)); Veynante, D.; Bourienne, F.; Candel, S.; Esposito, E.; Surget, J. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

An active instability control (AIC) system is used to suppress low-frequency combustion instabilities in a non-premixed multiple-flame combustor and to study their initiation. The AIC device is based on a feedback control loop: The signal provided by a microphone is filtered, processed and sent to driver units plugged on the air duct. It allows the suppression of all unstable modes of the combustor and also provides a new and powerful method to study the instability initiation. Starting from a controlled flame with AIC, the control system is switched off and the growth of the instability is analyzed through high speed Schlieren cinematography and sound pressure and reaction rate measurements. Nonlinear spectral analysis is used to extract spectral information during the oscillation growth from the initiation to the limit cycle. Results reveal that five different phases take place between stable combustion and fully established instability. The source of the first flame movements is the flow excitation by longitudinal acoustic waves. When the flow oscillation amplitude is high enough to allow interactions between flame sheets, combustion becomes periodically enhanced. This coupling leads to a fast instability growth until a limit cycle is reached.

47658 Driving of axial acoustic waves by side-wall stabilized premixed flames. Sankar, S.V. (Georgia Institute of Technology, Atlanta (USA)); Hegde, U.G.; Jagoda, J.I.; Zinn, B.T. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The mechanisms responsible for the driving of axial acoustic waves in a duct by a premixed, flat flame, stabilized on a side wall of the duct have been investigated both theoretically and experimentally. Measurements included acoustic pressures, burner surface admittances, and distributions of the temperature and heat release rates within the flame region. These revealed that the reaction rate oscillates with the frequency of the acoustic wave and that is possesses a spatial distribution which exhibits a large and a small peak upstream and downstream of the flat flame location, respectively. It is shown in the paper that the investigated flame driving is acoustically equivalent to that provided by a combination of a monopole and a dipole acoustic sources. These findings are in agreement with the predictions of the developed flame model which show that the flame driving is caused by the oscillation of the flame front relative to the duct side wall, caused by its interaction with the acoustic field. These newly uncovered flame driving mechanisms are believed to also play a role in solid propellant rocket motor instabilities where flame oscillations relative to the propellant surface will produce an oscillatory heat transfer to the propellant. This, in turn, will result in an oscillatory surface regression rate capable of driving the instability inside the rocket motor.

47659 Dynamics of stretched flames. Law, C.K. (Univ. of California, Davis (USA)). pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Recent advances in the understanding of the structure, propagation, and extinction of laminar flames under the influence of stretch, as manifested by the existence of flame curvature, flow nonuniformity, and flame motion, are reviewed. The emphasis is on premixed flames because of the richness and subtlety of the phenomena involved. The review distinguishes the influences of the tangential and normal velocity gradients on the flame response, both at the hydrodynamic scale and within the flame structure, and emphasizes the importance of the preferential diffusion nature of heat and mass transport, as well as the extend to which the flame can freely adjust its location in response to stretch in order to achieve complete reaction. It is then demonstrated that stretch has only minimal effect on an adiabatic, unrestrained, diffusionally-neutral flame with complete reaction in that the temperature, propagation rate, and thickness of the flame are invariant to stretch, and that stretch alone cannot extinguish such a flame. In the presence of preferential diffusion and/or when the flame movement is restrained, the response of the flame to stretch becomes more sensitive and extinction is also possible. The concept of flame stretch is applied to interpret such practical flame phenomena as flame stabilization and flame-front instability, determination of laminar flame speeds and flammability limits, concentration and temperature modifications in flame chemistry, and modeling of turbulent flames. The properties of stretched diffusion flames are then briefly discussed. The review closes with suggestions for further research. 149 refs.

47660 Multiphoton-excited fluorescence measurements of atomic hydrogen in low-pressure flames. Goldsmith, J.E.M. (Sandia National Laboratories, Livermore, CA (USA)). pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

This paper describes measurements of atomic hydrogen concentration profiles in six premixed low-pressure flames using three multiphoton-excited fluorescence detection techniques. Measurements were made in hydrogen-oxygen-argon flames at 72 Torr (Φ = 0.6 and 1.4), methane-oxygen flames at 30 Torr (Φ = 0.6 and 1.6), and acetylene-oxygen-argon flames at 25 Torr (Φ = 1.6 and 2.0).

The excitation techniques investigated were two-photon excitation using 205-nm radiation, three-photon excitation using 292-nm radiation, and two-step excitation using 243-nm and 656-nm radiation. Excellent agreement among the techniques was found for the hydrogen flames and the lean methane-oxygen flame; discrepancies were noted for the rich hydrocarbon flames, becoming increasingly significant at the higher equivalence ratios.

47661 Fluorescence studies of OH and CN radicals in atmospheric pressure flames using picosecond excitation. Schwarzwald, R. (Universitaet Heidelberg (West Germany)); Monkhouse, P.; Wolfrum, J. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Fluorescence lifetimes are reported for the OH ($A^2\Sigma^+$, $v' = 0$) and CN ($B^2\Sigma^+$, $v' = 0$) states in laminar, premixed hydrocarbon flat flames at atmospheric pressure. Measurements were made using a picosecond dye laser system based on the distributed feedback principle. Such lifetime measurements are needed for the determination of absolute species concentrations by laser induced fluorescence. Lifetimes for the OH A-state were determined in a methane/air flame and an average value of 1.97 ± 0.26 ns was obtained, irrespective of vertical position in the flame and of equivalence ratio in the range $\phi = 0.77$ to 1.43. For the CN B-state, lifetimes were determined in $CH_4/N_2O/N_2$ and $C_2H_4/N_2O/N_2$ flames and average values of 2.26 ± 0.23 ns and 2.39 ± 0.24 ns obtained respectively at the lowest position measurable in the flame (0.5 mm). Again, no significant change in lifetime was found with stoichiometry in the range $\phi = 1.02$ to 1.42 or with height above the burner.

47662 A structural study of a propane-oxygen diffusion flame diluted with argon. Evans, S. (Univ. of Manchester Institute of Science and Technology (England)); Simmons, R.F. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The temperature and composition profiles have been determined through a propane-oxygen diffusion flame diluted with argon and burning around a sintered cylindrical burner, including those for the intermediates ethene, propene, methane, acetylene and hydrogen. The measurements were closely spaced in the regions where composition changes were rapid, and this has enabled both diffusion velocities away from the burner surface and reaction rate profiles to be calculated. It was found that the removal of propane and oxygen was well separated spatially, but the latter occurred in the same region as the carbon dioxide and water were formed. The maximum rate of formation of carbon monoxide was well over on the rich side of the flame, in a region where the oxygen level was very low, but removal of water on the fuel side of the stoichiometric plane led to a persistence of hydroxyl radicals on to the rich side of flame. A detailed examination of the rate profiles in terms of both spatial position and mixture fraction gives fresh insight into the chemical processes occurring in the different regions of the flame and the way in which their interaction sustains the flame.

47663 Structures of wet CO flames with full and reduced kinetic mechanisms. Rogg, B. (Cambridge Univ. (England)); Williams, F.A. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Flame structures and deflagration velocities are calculated for $CO\text{-}O_2\text{-}N_2$ mixtures containing H_2 and H_2O with small H/C ratio, initially at 300 K and 1 atm. The calculations are completed with full chemical kinetics and with reduced mechanisms that retain fewer steps. Calculated burning velocities are in good agreement with experiment. The studies of reduced mechanisms reveal various aspects of the chemical-kinetic processes. Above a crossover temperature of about 1000 K, at which the rates of $H + O_2 \rightarrow OH + O$ and $H + O_2 + M \rightarrow HO_2 + M$ are equal, the O-atom and all hydrogen-containing species achieve steady states, so that a one-step approximation is obtained, from which burning velocities can be calculated more simply.

47664 Chemical structure of fuel-rich, premixed, laminar flames of trichloroethylene. Chang, W.D. (Illinois Institute of Technology, Chicago (USA)); Senkan, S.M. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The chemical structure of atmospheric-pressure, fuel-rich, premixed, laminar flames of C_2HCl_3 have been investigated using a flat-flame burner. Species mole fraction profiles were determined by using micro-probe sampling coupled with on line mass spectrometry for a flame with the following precombustion composition: 22.6% C_2HCl_3, 33.1% O_2, and 44.3% Ar, corresponding to an equivalence ratio of 1.36. In addition to the major combustion products, which include CO, $COCl_2$, HCl, Cl_2, C_2Cl_4, C_2Cl_2, CCl_4, a number of new intermediates including C_2HCl_3O, C_2Cl_4O, C_3Cl_4O, C_2HCl_5, C_3HCl_5, C_2Cl_6, C_3Cl_4, C_3Cl_6 and C_4Cl_6 have been identified and quantified. The role of these intermediates, in view of the current ideas of the mechanism of combustion of C_2HCl_3 is discussed.

47665 Structure and extinction limits of counterflow diffusion flames of hydrogen-nitrogen mixtures in air. Dixon-Lewis, G. (Univ. of Leeds (England)); Missaghi, M. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The paper describes the results of a numerical investigation of the structure and properties of counterflow diffusion flames in three fuel-air mixtures, in which the fuels are respectively pure hydrogen, an equimolar mixture of hydrogen and nitrogen, and a mixture of 21 percent hydrogen and 79 percent nitrogen. The extinction limits of all three flames are examined, and occur at velocity gradients of 13000, 8600 and 1520 s^{-1}, with maximum temperatures of 1422, 1308 and 1214 K respectively. An additional property of diffusion flames is that there is a minimum oxygen content of the nitrogen-oxygen mixture (or air) below which no flame can be established. When the fuel is pure hydrogen, this minimum mole fraction is found numerically to be 0.052. The properties of all the flames are discussed in relation to their chemical mechanism. The major radical production in all the flames is centered more or less on the stoichiometric position, and near the position of maximum temperature. The dominant heat release is always on the fuel-lean side of the flame, and occurs by way of the HO_2 cycle of reaction in the hydrogen-oxygen system. These heat release rates increase with increasing strain rate or velocity gradient, and this is related with increased concentrations of hydrogen and oxygen in the reaction zone, at the expense of lower reactedness and lower temperatures. Eventually the temperature becomes so low that the radical production mechanism fails and the flame extinguishes.

47666 Structure of opposed jet premixed flame and transition of turbulent premixed flame structure. Yoshida, Akira (Tokyo Denki Univ. (Japan)). pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A distributed reaction zone was achieved successfully in the laboratory by an opposed jet burner. This burner consists of two opposed mixture supply tubes with water-cooled disks. An annular turbulent premixed flame is produced around the impinging mixture jets. In the present paper, the structure of the opposed jet flame was characterized and, by comparing with the tube burner flame, the transition mechanism from wrinkled laminar flame to distributed reaction zone was discussed. On the unburned gas side of the opposed jet burner flame, the essential feature of the temperature pdf is bi-modal with relatively high probability of intermediate temperature. In this region, a thick wrinkled (not laminar) flame structure is found in which small dissipative eddies are embedded. In the middle and the burned gas regions, the probability of unburned mixture disappears and that of intermediate temperature increases, which suggests that the flame zone consists of the small eddies of completely burned and partially reacted gases. By velocity measurements with an LDV and a hot wire anemometer, it was found that, for low turbulence Reynolds numbers, a fully developed wrinkled laminar flame is produced by increasing the Damkohler

number. Also it was found that, for nearly constant Damkohler numbers, the fully developed wrinkled laminar flame structure changes to the distributed reaction zone with increasing the turbulence Reynolds number.

47667 A computational model of the structure and extinction of strained, opposed flow, premixed methane-air flames. Kee, R.J. (Sandia National Laboratories, Livermore, CA (USA)); Miller, J.A.; Evans, G.H.; Dixon-Lewis, G. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The application of laminar flamelet concepts to turbulent flame propagation requires a detailed understanding of strained laminar flames. Here the authors use numerical methods, including arc-length continuation, to simulate the complex chemical kinetic behavior in premixed methane-air flames that are stabilized between two opposed-flow burners. They predict both the detailed structure and the extinction limits for these flames over a range of fuel-air mixtures. In addition to discussing the flame structure, a sensitivity analysis provides further insight on the chemical behavior near extinction. Finally, they discuss the comparison of the predictions with Law's experimental extinction data. An especially important aspect of this comparison is the recognition that fluid mechanical aspects of the traditional strained-flame analysis are deficient in representing experiments such as Law's. The authors develop and solve a new system of equations that is able to describe the experiments much more accurately.

47668 Opposed-flow flame spread and extinction in mixed-convection boundary layers. Altenkirch, R.A. (Univ. of Kentucky, Lexington (USA)); Vedha-Nayagam, M. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Experimental data for flame spread down thin fuel samples in an opposing, mixed-convection, boundary-layer flow are analyzed to determine the gas-phase velocity that characterizes how the flame reacts as it spreads toward the leading edge of the fuel sample into a thinning boundary layer. In the forced-flow limit where the cube of the Reynolds number divided by the Grashof number, Re^3/Gr, is large, L_q/L_e where L_q is a theoretical flame standoff distance at extinction and L_e is the measured distance from the leading edge of the sample where extinction occurs, is found to be proportional to Re^n with n = -0.874 and Re based on L_e. The value of n is established by the character of the flow field near the leading edge of the flame. The Re dependence, which implies a gas-phase velocity of importance of $v_{infinity}/(L_e Re^n)$, is used, along with a correction for the mixed-convection situation where Re^3/Gr is not large, to construct a Damkohler number with which the measured spread rates correlate for all values of Re^3/Gr.

47669 Recirculating flow over a burning surface - flame structure and heat transfer augmentation. Raghunandan, B.N. (Indian Institute of Science, Bangalore (India)); Yogesh, G.P. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The separated flow in the presence of obstructions to the flow and surface blowing as encountered in many practical heat transfer and heterogeneous combustion problems is investigated. The experimental simulation in a two-dimensional geometry has enabled the estimation of heat transfer rates to the wall as well as flow visualization. The measured heat transfer coefficients and the observed flow patterns reveal a relation between the two even in this complex flow configuration wherein a two-vortex pattern dominates. The observations made in relative and nonreactive flow conditions exhibit many common features indicating that the rather rigid flame at the boundary of the primary vortex results in the same heat transfer trends as would an equally hot core flow.

47670 Effects of curvature on extinction of premixed flames stabilized in stagnation flow. Asato, Katsuo (Gifu Univ. (Japan)); Kawamura, Takeshi; Ban, Tatsuya. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Characteristics of laminar premixed flames convex to uniform stream of unburned mixture, which were established in the stagnation region of a jet and the uniform stream opposing each other, were studied experimentally. The effects of flame curvature and the combined effects of the curvature and the Lewis number (Le) on the extinction of the convex flame were discussed, and the results were contrasted with those obtained from premixed flat flames established in the stagnation flow. The main conclusions obtained are summarized as follows: (1) In the lean methane flames of Le = 1.0, the convex flames are extinguished close to the stagnation point in the same manner as the flat flames. In the lean propane flames of Le < 1.0, the convex flames are extinguished further away from the stagnation point compared with the flat flames. (2) In the lean methane flames of Le = 1.0, the flame temperature of the convex flames at the extinction limits is nearly equal to that of the flat flames. In the lean propane flames of Le < 1.0, the flame temperature of the convex flames at the extinction is higher than that of the flat flames. (3) In the methane convex flames of Le = 1.0, the flame curvature promotes further the incomplete combustion at the head of the convex flame compared with the flat flames, as the flame approaches the extinction limits. In the propane convex flames of Le < 1.0, the outflow of heat from the flame is relatively so increased that the flame curvature plays a role to decrease apparently the Lewis number, approaching the extinction.

47671 Detailed numerical simulations of cellular flames. Patnaik, G. (Berkeley Research Associates, Springfield, VA (USA)); Kailasanath, K.; Oran, E.S.; Laskey, K.J. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Time-dependent, two-dimensional simulations of perturbed premixed laminar flames have been used to study the development of cellular structures in rich and lean hydrogen flames. The model includes detailed hydrogen-oxygen combustion with 24 elementary reactions of eight reactive species and a nitrogen diluent, molecular diffusion of all species, thermal conduction, and convection. Calculations of perturbed lean hydrogen flame evolution showed that the flame was unstable at the front, and the structure that evolved resembled cellular structures observed in experiments. The same perturbation applied to a rich hydrogen flame showed that the perturbation died out and cellular structures did not appear. Binary diffusion coefficients were varied to test the role of molecular diffusion in the development of cellular structure. When the coefficient of molecular diffusion in the development of cellular structure. When the coefficient of molecular hydrogen was set equal to that of molecular oxygen, the perturbation died out; when the coefficient of molecular oxygen was set equal to that of molecular hydrogen, the instability persisted. The results of the simulations support the diffusional-thermal theory of flame instability.

47672 Anomalous Lewis number effects in tribrachial flames. Buckmaster, J. (Univ. of Illinois, Urbana (USA)); Matalon, M. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Tribrachia (three-armed) flames are generated when a premixed flame propagates into a nonuniform mixture, and consist of a fuel-rich branch joined to a fuel-lean branch, with a diffusion flame trailing from the junction (the stoichiometric point). They are important in the context of laminar flamelet models of turbulent non-premixed flames. The authors provide a theoretical description of these flames, valid when the upstream concentration gradient is small. In addition, they assume that the Lewis Number of the oxidizer is 1, but that of the fuel (Le_f) is greater than 1. Solutions are sought corresponding to steady, unbounded propagation into unburnt mixture, where they would expect-nominally-that all three arms of the flame trail behind the junction, so that to the left of some plane perpendicular to the oncoming flow there is everywhere no reaction. Instead, the authors find that the fuel-rich branch necessarily extends ahead of any plane, penetrating to upstream infinity. This corresponds to an anchored flame rather than one that is

freely propagating, and appears to be a consequence of the stretch effects that are possible when $Le_f > 1$; a decrease in the mixture strength does not necessarily lead to a decrease in the local flame speed if flame curvature generates negative stretch. If they assume that extinction occurs at sufficiently low flame temperatures, the flame is bounded and the solution can be reinterpreted as a freely-propagating flame, albeit with unexpected shape.

47673 Flammability limits for exhaust gas diluted flames. Blint, R.J. (General Motors Research Laboratories, Warren, MI (USA)). pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Flammability limits of propane/air (ϕ = 1.0) flames diluted by exhaust gases have been determined by extrapolating the calculated laminar flame speeds to a minimum flame speed limit as a function of pressure, dilution and unburned gas temperature. The flame speed calculations show an approximately linear decrease in flame speed with dilution. This result compares well with the two available experimental determinations of the functional behavior of the flame speed with dilution. The flammability limits for these diluted flames decrease monotonically, but not linearly with pressure. The limits do, however, increase with unburned gas temperature. A typical dilution limit is 38% by volume of exhaust gases for an unburned mixture temperature of 500 K and a pressure of 4 atmospheres. Length scales based on these laminar flame calculations were also determined. These length scales are an indicator of the turbulent flame structure. The results presented here show that dilution causes a large increase in the flame widths. This large increase in the flame width is sufficient to change the turbulent flame structure from a well defined wrinkled flame to a regime which is somewhere between the extremes of a wrinkled flame and the distributed reaction. This means that the turbulent flame structure in a homogeneous-charge, S.I. engine operating with a sufficiently diluted mixture may be much different than that which has been previously assumed.

47674 The structure an extinction of partially premixed flames burning methane in air. Smooke, M.D. (Yale Univ., New Haven, CT (USA)); Seshadri, K.; Puri, I.K. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Results of experimental and numerical studies of counterflow, partially premixed, flames burning methane in air are reported. Experimental data is obtained for the temperature profile, the axial velocity profile, the concentration profiles of various stable species and the critical conditions of the flame at extinction. The results are compared with numerical calculations performed at conditions identical to those used in the experiment. Experimental measurements and numerical calculations show that partial premixing of the reactant streams of a counterflow diffusion flame makes the flame less resistant to stretch. In addition, numerical calculations show that the reaction zone of a partially premixed flame exhibits a diffusion flame and a premixed flame-like structure. Both results are consistent with previous asymptotic analyses of the structure of partially premixed flames.

47675 Extinction of near-stoichiometric flames diluted with nitrogen in a stagnation flow. Yamaoka, Ichiro (Noritz Corporation, Hachioji (Japan)); Tsuji, Hiroshi. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Experimental studies of the behavior and extinction of the near-stoichiometric flames diluted with nitrogen in a stagnation flow were made using counterflow twin flames established in the forward stagnation region of a porous cylinder. Methane-air and propane-air flames were used in the experiment. The extinction limit of the twin flames, the flame separation distance at extinction, the concentrations of some stable species on the stagnation surface of the flames very near the extinction limit and the limit flame temperature at extinction were measured, and the behavior, extinction mechanism and the flammability limits of the near-stoichiometric flames diluted with nitrogen are discussed. The position of the maximum allowable dilution by nitrogen for twin flames burning in a stagnation flow depends on preferential diffusion of the more diffusive reactant (either fuel or oxygen). For methane flames, this position is found on the slightly fuel-lean side (the equivalence ratio of the mixture ψ = 0.95), but for propane flames, this position on the considerably fuel-rich side (ψ = 1.25). With the increase of ψ, the limit flame temperature and the flame separation distance at extinction increase for methane flames, but decrease for propane flames. For the stoichiometric methane flame and propane flame, flame extinction occurs at a finite distance from the stagnation surface. These experimental results are discussed on the basis of preferential diffusion and the Lewis Number effect. Moreover, some discussion on the flammability-limit problems of the near stoichiometric fuel-air nitrogen mixtures is made.

47676 Behavior of methane-oxygen-nitrogen mixtures near flammability limits. Lakshmisha, K.N. (Indian Institute of Science, Bangalore); Paul, P.J.; Rajan, K.S.; Goyal, G.; Mukunda, H.S. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Results of the detailed calculations using one-dimensional adiabatic premixed flame model for mixtures near inflammable compositions are reported. The effect of nitrogen as a diluent on the flame structure and speed are studied for stoichiometric and fuel-lean mixtures of methane and oxygen. The results indicate that while a fundamental limit in terms of a cut-off composition may not exist for the mathematical solution, the numerical solutions show an asymptotic limiting behavior as extreme compositions are reached. An attempt is made to explain the limits on the basis of rapid depletion of radical species and a steep increase in the flame thickness. Oscillations-which sometimes are said to indicate inflammability limits-are found to be of numerical origin.

47677 Radiation-dominated propagation and extinction of slow, particle-laden gaseous flames. Joulin, G. (Laboratoire d'Energetique et Detonique, Poitiers (France)); Eudier, M. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The authors study slow, planar steady flames propagating in weakly energetic gaseous premixtures which are seeded with inert, solid particles. Attention is focused on the radiative transfer, when a mechanism of kinetic quenching exists. Assuming low burning velocities and particle concentrations, and a strongly temperature-dependent reaction rate they employ asymptotic methods to get the flame structure and velocity, analytically. The authors show that adding inert particles to a non-flammable reactive gaseous mixture may make it flammable. A shifted extinction at finite burning speed is evidenced; it results from a competition between mixture loading by the suspension, chemical quenching, radiative preheating and radiant losses from a thin flame to its cooler surroundings.

47678 The inhibiting effect of CF_3H on the structure of a stoichiometric $H_2/CO/O_2/Ar$ flame. Vandooren, J. (Universite Catholique de Louvain, Louvain-la-Neuve (Belgium)); da Cruz, F.N.; Van Tiggelen, P.J. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The structure of two premixed stoichiometric $CO/H_2/O_2/Ar$ flat flames, one uninhibited and the other inhibited by 3% of CF_3H, has been established at 4.65 kPa by using a mass spectrometric analyzer coupled with molecular beam sampling. This initial content of H_2 was 2% and the H/F initial ratio was 0.78. The main effect of the CF_3H addition concerns essentially the smaller CO conversion and the formation of lower quantities of H_2O, OH and H species. The production of HF and CF_2O predominates over the formation of other hydrogen compounds, such as H, OH and H_2O; HF and CF_2O remain in the burnt gases. The inhibiting efficiency of CF_3H is much less marked than that observed in CF_3Br-seeded flames. It is due to the formation of H_2 instead of HBr in the first step of the inhibition mechanism $CF_3H + H \rightarrow CF_3 + H_2$ and to a lower rate constant $k_6 = 2.4 \times 10^{14} \exp(-6350/T)$ $cm^3\ mol^{-1}\ s^{-1}$. Moreover the further reaction of CF_3 with OH, $CF_3 + OH \rightarrow CF_2O + HF$ is responsible for the net loss of chain carrier radicals. Finally, CF_2O will

react slowly with hydrogen atoms $CF_2O + H \rightarrow CFO + HF$ and its rate constant is probably very sensitive to temperature. The above mechanism explains also the macroscopic inhibiting effect of CF_3H as compared with that of CF_3Br.

47679 Oscillatory combustion in closed vessels: Theoretical foundations and their experimental verification. Griffiths, J.F. (Univ. of Leeds (England)); Kay, S.R.; Scott, S.K. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Cool flames accompanying the spontaneous combustion of gaseous hydrocarbon fuels are a familiar manifestation of oscillatory chemical reactions in combustion systems. The possibility of oscillatory instability is of importance technically, as well as of general interest, and its consequence can be as significant as those of ignition and extinction. Clear experimental tests of theoretical predictions for the onset and growth of oscillations have been complicated by the intricate kinetic mechanism involved. Complex kinetics is not, however, a necessary pre-requisite for oscillations. The authors have devised, and realized experimentally, the simplest thermokinetic oscillator in a well-stirred closed vessel (semi-batch reactor) by adaptation of a scheme suggested by Salnikov. Only one chemical reaction occurs and this is a first-order step. Reaction is exothermic and operates under non-isothermal, non-adiabatic conditions. The novel technique employed here is that of a slow, controlled entry of the reactants via a calibrated capillary rather than the usual rapid admission. The reaction exothermicity is an important parameter determining the existence of oscillations and can be tuned as required, without altering the reaction kinetics, by the addition of oxygen. The conditions for the onset and growth of oscillatory responses are predicted analytically on the basis of a simple model. The system allows the quantitative identification of the required relative magnitudes of the characteristics timescales for chemical reaction and Newtonian heat transfer. The ramifications of these results for the combustion of hydrocarbons where there is an inseparable coupling of both thermal and chemical feedback is discussed.

47680 Measurement of slow burning velocity by zero-gravity method. Kawakami, T. (Hosei Univ., Tokyo (Japan)); Okajima, S.; Iinuma, K. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The authors have developed a successful technique to determine with high accuracy the burning velocity as slow as a few centimeters per second, using a spark-ignited spherical flame under a zero-gravity condition realized in a freely falling chamber. The values of burning velocities for extremely lean and rich propane-air mixtures were obtained by taking schlieren streak photographs with a drum camera installed on a falling assembly. As the next step of this study, the authors have conducted experiments to determine the burning velocity and its pressure-dependence of methane-air mixtures, up to the flammability limits and 0.8 MPa of initial pressure, using the same technique as in the previous investigations. The values of burning velocities have been evaluated considering the density ratio with the flame thickness correction, where the temperature profile is assumed to be linear from the burnt to unburnt side and the burnt gas is at the adiabatic flame temperature. The results have been compared with those determined by other studies.

47681 On the mechanisms of flame propagation limits and extinguishment processes at microgravity. Ronney, P.D. (Princeton Univ., NJ (USA)). pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Microgravity (μg) experiments are employed to study the behavior of freely propagating spherically expanding premixed gas flames near the flammability limit in the absence of flow induced by natural convection. Temporally and spatially resolved temperature measurements in near-limit normal flames and Self-Extinguishing Flames at μg are obtained. From comparison of these data to a simple numerical model, it is determined that the primary mechanism of heat loss from these flames is by nonluminous radiation from the burned gases. Based on comparison with existing theories of flammability limits it is found that some of the experimentally observed limits are probably caused by these heat losses. A simple theory of nonadiabatic propagation of curved flame fronts with general Lewis number is found to describe many of the features of the μg (convection-free) flammability limits and extinguishment processes.

47682 JSFR (Jet Stirred Flow Reactor) combustion processes of n-heptane and isooctane. Lignola, P.G. (Universita della Calabria (Italy)); Di Maio, F.P.; Marzocchella, A.; Mercogliano, R.; Reverchon, E. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Combustion processes of n-heptane and isooctane have been studied in a Jet Stirred Flow Reactor (JSFR), which operates according to the Continuous Stirred Tank ideal model of reactor. The range of experimental conditions spanned from 202 to 1212 kPa and from 573 to 840 K. The feed consisted of stoichiometric fuel/air mixture and flow rates were such to establish a 0.4 s residence time. The analysis of dynamic behavior of combustion processes showed that the same variety of dynamic events is exhibited by both fuels, namely: slow combustion, low temperature multistage ignition, damped and periodic cool flames, jumps and high temperature ignitions. Heat release rates have been measured experimentally and their dependence on temperature clearly shows the region of existence of negative temperature coefficient of the reaction rate. The analyses of reaction intermediates indicate that fuel molecules are not heavily degraded at the sampling conditions which are located in the negative temperature coefficient region. The major differences between the combustion processes of the two fuels are in the pressure limit of the region of low temperature multistage ignition and in the presence of acetaldehyde among the reaction intermediates detected only for the n-heptane/air system. On this basis, the hypothesis is formulated that the different knock resistance of the two fuels could well be caused by the differences of the low temperature mechanisms and by the ability of producing acetaldehyde at an early stage of the combustion process.

47683 Ignition and combustion of metals in a carbon dioxide stream. Yuasa, Saburo (Tokyo Metropolitan Institute of Technology (Japan)); Isoda, Hiroshi. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

In the prospect of using metals as fuel of breathing combustion engines in carbon dioxide rich planet atmospheres without oxygen such as those of Mars and Venus, a fundamental study was performed experimentally on the ignition and combustion of metals in an impinging pure CO_3 gas stream. Metals selected were lithium, magnesium, boron and aluminum, because of their high heats of reaction with CO_2. Li and Mg could ignite spontaneously in the CO_2 stream. The ignition process of Li in the CO_2 stream had two distinct steps, first a surface reaction and then a gas phase reaction. This process was found to be similar to those of Mg and Na in air streams, but was different from that of Li in an air stream. Mg could burn in vapor-phase. B could not ignite in the CO_2 stream, but the reactions occurred appreciably on the surface. The reaction rate was quite slow, compared with that in an oxygen stream, and the molten boron oxide appeared on its surface. Al could not ignite within the temperature limits of the apparatus. However, the possibility of its ignition and combustion in the CO_2 stream was demonstrated in a different experiment allowing the attainment of somewhat higher temperatures.

47684 Pulsed plasma jet igniters: Species measurements in methane combustion. Lucas, D. (Univ. of California, Berkeley (USA)); Cavolowsky, J.A.; Breber, P.R.; Oppenheim, A.K. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). DOE Contract AC03-76SF00098. From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The authors have measured species concentration histories in the plume of a pulsed plasma jet igniter during ignition and subsequent combustion of methane/oxygen/nitrogen and methane/oxygen/argon mixtures using molecular beam mass spectrometry. Equivalence ratios of 1.0, 0.6, and 0.4 were used in the igniter cavity and in the

main combustion chamber to provide both combusting and noncombusting cases. Species measurements indicate that combustion initiated by plasma jets can be divided into three time periods: a very hot initial stage, where high temperature species formed both in the plasma cavity and in the turbulent plume dominate, a second region where entrainment continues along with the production of products in the plume but not in the bulk gas mixture, and finally flame propagation through the combustible mixture. High radical concentrations characterize the first stage; N atoms peak at a mole fraction of 0.004, and OH reaches a value of 0.007 in the stoichiometric case. The second stage involves the reactions of intermediate products such as H_2, NO, and CO along with the production of final, stable products. In the final stage, CO_2 and H_2O concentrations rise to levels expected from complete combustion of the reactants. These measurements are used to explain how pulsed plasma jets enhance ignition in lean mixtures.

47685 Energy requirements for spherical ignitions in atmospheric-pressure methane-air mixtures: A computational study. Sloane, T.M. (General Motors Research Laboratories, Warren, MI (USA)); Schoene, A.Y. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

This paper addresses the calculated dependence of the minimum ignition energy and the ignition delay on the form in which the ignition energy is added, either as thermal energy or a combination of thermal energy and dissociation of the fuel or oxygen. The majority of these calculations were performed in atmospheric-pressure, stoichiometric methane-air mixtures. Ignition energy was added as an initial condition in the form of heat and dissociation of methane and oxygen. The distribution of ignition energy between heat and dissociation had only a small effect on the minimum ignition energy, but had a dramatic effect on the ignition delay. As the fraction of ignition energy deposited in dissociation of oxygen and methane increased for these mixtures, the minimum ignition energy decreased by about 6%, then increased. The ignition delay, however, was found to be much shorter when a substantial fraction of the ignition energy was added as dissociation compared to the case where the ignition energy was added in the form of heat only. The minimum ignition energy was found to be most sensitive to the reaction H + O_2 = OH + O. Although the reaction CO + OH = CO_2 + H is the major exothermic contributor in flames, it was not a major contributor to the exothermic phase of the ignition process. The H + O_2 reaction controls the availability of reactants for the principal exothermic reactions which dominate the heat release during these ignitions.

47686 Dynamic effects of autoignition centers for hydrogen and $C_{1,2}$-hydrocarbon fuels. Lutz, A.E. (Sandia National Laboratories, Livermore, CA (USA)); Kee, R.J.; Miller, J.A.; Dwyer, H.A.; Oppenheim, A.K. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A chemical kinetics model is used to compute the dynamics of a local autoignition center in a combustible mixture. Such centers arise from inhomogeneities in the bulk mixture and ignite earlier than the surrounding mixture. The model of an exothermic center considers a small, homogeneous mass of reacting mixture that is surrounded by an inert mixture. The model combines energy and species equations for the reacting mixture with a gas dynamic constraint for the expansion of the exploding center. The induction time, the time of chemical energy release, and the exothermic energy and power of the centers are evaluated for a variety of stoichiometric fuel-air mixtures. Fuels include hydrogen, methane, acetylene, ethylene, and ethane. An important dynamic effect of the center is the compression wave it produces in the surrounding mixture. The computations show that compression ratios of 1.2 to 1.8 are produced by a center in these fuels at high pressure.

47687 Ignition processes in carbon-monoxide-hydrogen-oxygen mixtures. Maas, U. (Universitaet Heidelberg (West Germany)); Warnatz, J. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Ignition processes in the carbon monoxide-hydrogen-oxygen system are simulated by solving the corresponding conservation equations (i.e. conservation of mass, energy, momentum and species mass) for one-dimensional geometries using a detailed reaction mechanism and a multi-species transport model. An additional source term in the energy conservation equations allows the treatment of induced ignition, and a realistic model for the destruction of reactive species at the vessel surface is used to treat auto-ignitions in static reactors. Spatial discretization using finite differences and an adaptive grid point system leads to a differential/algebraic equation system which is solved numerically by extrapolation or backward differencing codes. Minimum ignition energies are calculated for various mixture compositions and radii of the external energy source. Ignition limits are computed, and a sensitivity analysis shows the rate-limiting reactions.

47688 Rate-controlled constrained equilibrium calculation of ignition delay times in hydrogen-oxygen mixtures. Law, R. (Northeastern Univ., Boston, MA (USA)); Metghalchi, M.; Keck, J.C. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The Rate-Controlled Constrained-Equilibrium (RCCE) method has been used to describe the evolution of the hydrogen-oxygen system. Stoichiometric mixtures of hydrogen and oxygen having initial temperatures in the range 900 K to 1500 K and pressures in the range 0.1 atm to 10 atm were studied. The state of the system was determined by imposing constraints on the total moles of gas, the moles of free valence and the moles of active valence. The rate equations for these constraints were integrated for various one and two constraint combinations to obtain temperature-time profiles at constant volume and energy. Reasonable agreement with results obtained by integrating a full set of nine rate equations was obtained over a range of ignition delay times spanning five orders of magnitude using just two constraints corresponding to total moles and moles of active valence.

47689 Propagation mechanism of quasi-detonations. Teodorczyk, A. (McGill Univ., Montreal (Canada)); Lee, J.H.S.; Knystautas, R. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The propagation mechanism of quasi-detonations in very rough tubes is studied using high speed schlieren photography. Stoichiometric mixtures of H_2, C_2H_4 and C_3H_8 in oxygen at an initial pressure range $10 \leq p_o \leq 160$ torr are investigated in a 61.8 x 61.8 mm by 1.5 m long channel with two-dimensional obstacles with a height of 25.4 mm and for various obstacle spacings. The results indicate that shock reflections (transition from regular to Mach reflections) from the walls lead to re-initiation. The obstacle spacing is found to represent an effective reaction zone length (or cell length) of the quasi-detonation. At the critical condition of transition from the choking to the quasi-detonation regime, this effective reaction zone length is found to be about twice the normal cell length of the mixture in accordance with Shchelkin's stability criterion for a perturbed wave. The minimum open dimension of the channel is found to be of the order of a cell size λ for transition to the quasi-detonation regime in agreement with the previous results of Peraldi and Gu for rough tubes. Photographic observations of the propagation mechanism in the choking regime reveal the absence of ignition via shock reflection. The placement of wire screens to damp the shock reflections at the channel walls suppresses the transition to quasi-detonations indicating the essential role of shock reflections. It is not clear whether the adiabatic heating or the turbulent vortex mixing associated with the shear layer wall jet by the Mach stem near the wall is the responsible mechanism for re-initiation..

47690 The structures of fast deflagrations and quasi-detonations. Chan, C.K. (Atomic Energy of Canada Limited, Pinawa, Manitoba); Greig, D.R. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Flame propagation for stoichiometric H_2-O_2 mixtures (p_o < 150 Torr) in a channel filled with obstacles has been examined. It was observed that, upon ignition by a glow plug, the resulting flame accelerated very rapidly as it propagated down the channel. Eventually, it either reached a steady-state velocity as a fast deflagration or became a quasi-detonation by way of a transition. The structures of these two forms of combustion waves were examined using schlieren photography, pressure transducers and smoke foils. The controlling mechanisms for the propagation of the two waves were found to be turbulent burning and shock heating, respectively. Results showed that obstacles inside the channel play a key role in the propagation of fast deflagrations and quasi-detonations. In a case of a fast deflagration, the reaction zone is perturbed repeatedly by the obstacle-induced transverse waves; as a result of shock-flame interaction, the high burning rate is maintained. On the other hand, the presence of obstacles prevents a quasi-detonation from propagating at the Chapman-Jouguet detonation velocity.

47691 A comprehensive model for the structure of dust detonations. Fan, B.C. (Univ. of Michigan, Ann Arbor (USA)); Sichel, M. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A comprehensive analytical model has been developed to describe the structure of dust detonations which simultaneously computes both the induction and reaction zones. Heterogeneous reactions which occur on the external particle surface and on the surface of pores within the particle are sued to model the chemistry. The overall reaction rate in the induction zone is controlled by the heterogeneous surface reaction ate while in the reaction zone diffusion of the gas into the pores is found to be the rate limiting step. Conduction heat transfer within the particles, convective heat transfer between the particles and the gas and chemical heat release within the particles are considered in this model to describe the temperature distribution within the particles in both the induction and reaction zones. Thermal runaway is sued as the criterion of ignition at the end of the induction zone and the singularity at the C-J plane is used to terminate the reaction zone. Because of a lack of sufficient data, some constants used in this model were chosen to provide the best fit between the theory and experiment. The model made it possibie to compute the structure of dust detonations without separate treatment of the induction and reaction zones and was used to determine the effects of particle size on detonation structure and propagation velocity. In those case in which experimental data was available computed and measured results were in good agreement.

47692 Detonation waves through foam. Segev, G. (Technion-Israel Institute of Technology, Haifa); Hasson, A.; Siman, M.; Burcat, A. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Detonation waves in plain gas and gas trapped in a light water based foam, were compared to find out if there is a connection between the detonation velocity achieved in the foam, to the size of the foam bubbles, and if such a connection can give an indication of the size of the detonation cells in the given gas mixture. Basically two phenomena are investigated (a) the basic detonation parameters in the two media, and (b) comparison of the deflagration to detonation transition (DDT). The explosive gas contained pure ethylene in oxygen. The concentrations of the fuel ranged between 9 to 44 percent. All mixtures were tested with and without foam. Bubbles of sizes between 1 and 13 mm were generated. The amount of water in the foam was also recorded. The results identify two distinct concentration regions: (A) Mixtures between 16 to 40 percent fuel (equivalence ratios ϕ = 0.61-2.0), where the DDT process was instantaneous or very close to it. A very modest damping of the detonation velocity was detected reaching in extreme cases up to 8 percent. The variation in the sizes of foam bubbles showed no dramatic changes. (B) In mixtures containing between 9 to 16 percent fuel (ϕ = 0.30-0.61) where changes in DDT time are encountered according to changes in concentration, drastic influence of the foam is found. The presence of foam bubbles starting from certain sizes and upward, shorten the DDT time between 60 to 75 percent and more.

47693 Burning rates in turbulent fine dust-air explosions. Bradley, D. (Univ. of Leeds (England)); Chen, Z.; Swithenbank, J.R. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Turbulent burning velocities of a cornflour-air premixture (mean diameter 10.6 μm) have been measured by high speed schlieren cine photography, during the pre-pressure period in a fan-stirred explosion bomb. Measurements were at different fan speeds, to ascertain the effects of turbulence. It was found that the correlation of the ratio of turbulent to laminar burning velocities with the ratio of effective r.m.s. turbulent velocity to laminar burning velocity and the Karlovitz flame stretch factor is similar to that with gaseous premixtures. This suggests the importance of gas phase reactions in driving the flame propagation. Both compensated thermocouple measurements of gas temperature and those of mean density behind the flame front, derived from the flame speed and the turbulent burning velocity, showed dust flames to be thicker than gaseous flames. This is attributed to the time lag in the heating and devolatilizing of the particles. Radiative loss also is significant. Values of the burning velocity based upon the actual mass rate of burning are presented and these are lower not only than those in gaseous explosions but also than the turbulent burning velocity. This mass burning velocity is related to the scaled pressure rise parameter, K_{st}, much used in hazard analysis, and comparisons are made with previously reported dust explosion data on the basis of this relationship.

47694 The investigation of the feature of dispersion induced turbulence and its effects on dust explosions in closed vessels. Pu, Yi Kang (Institute of Mechanics, Beijing (China)); Jarosinski, J.; Tai, Chang Sheng; Kauffman, W.C.; Sichel, M. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The integral scales and rms turbulent velocities of dispersion induced turbulence measured in three explosion vessels of different sizes (6, 26, and 950 liter) and shapes, with different dispersion systems, are within the ranges of 0.4-1.6 cm and 0.5-3.3 m/s. Experimental results demonstrate that a steady turbulent flow acts on the combustion process in the 950 liter sphere, while a transient turbulent flow occurs in the 6 liter bomb and 26 liter closed tube. The numerical values of the turbulent burning velocity are determined as a linear function of the rms turbulent velocity produced by the pneumatic dispersion systems in cornstarch-air mixtures. These values are compared with the data, which were determined under the same experimental conditions using the same procedure for experiments, for methane-air mixtures. Because the order of magnitude of turbulent burning velocities measured in cornstarch flames is the same as in lean methane flames, it is inferred that the processes controlling flame propagation in these flames should be similar. The integral scale of turbulence produced by these dispersion systems is of the same order of magnitude as the laminar flame thickness, and the rms turbulent velocity is much larger than the laminar burning velocity in both the cornstarch-air and lean methane-air mixtures. As a result of these relations the ratio of the mixing rate to the chemical reaction rate is higher than eight, which indicates that the flames propagate under conditions close to those in which quenching by turbulence takes place.

47695 Comparative study of the influence of obstacles on the propagation of dust and gas flames. Pu, Yi Kang (Institute of Mechanics, Beijing (China)); Mazurekiewicz, J.; Jarosinski, J.; Kauffman, C.W. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The well known technique to accelerate gas flames by introducing obstacles has been used for studying the properties of dust flames. To study in detail the mechanism of flame acceleration by means of obstacles some tests were carried out in an open 5 cm x 5 cm square tube 1 meter long modified for visualization of the combustion process. The propagation of both dust and gas flame was

studied. Analysis of the results show that flame acceleration in obstacle environments is due mainly to the effects of nonuniformity of the mean velocity across the tube. The explosion characteristics of gas and dust flames have been investigated in a closed tube 0.19 meters in diameter and 1.86 meters long, filled with obstacles. A comparative study of flame propagation velocity and the maximum rate of pressure rise shows the similarity between flame propagation in a premixed cornstarch-air mixture and in a lean limit methane-air mixture. This similarity agrees with some conclusions obtained from the previous research, which indicated that the fundamental characteristics (such as the minimum quenching distance and the minimum ignition energy) between the above flames are comparable. It is inferred that there is some similarity in the processes controlling flame propagation in these flames.

47696 Numerical simulation study of a hydrazine/nitrogen dioxide diffusion flame in a Burke-Schumann burner. Hepler, W.A. (Univ. of California, Los Angeles (USA)); Smith, O.I. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The conservation equations in the boundary layer form have been solved for co-axial flowing streams of hydrazine and nitrogen dioxide. Detailed chemical kinetics and transport were used in the simulation which included 22 species (plus diluent) and 151 reactions. The solution is compared with the classic Burke-Schumann solution, and individual elements of the Shvab-Zeldovich approximations pertaining to the latter are examined. The numerical solution with detailed chemistry shows good qualitative agreement with the classic Burke-Schumann solution for general flame shape and major species profiles. Quantitative discrepancies arise from the use of the flame sheet approximation and to changes of ρD with temperature and composition. Additional discrepancies arise from the use of detailed chemistry which allows for the consumption of reactants by intermediate species and by unimolecular processes.

47697 Hydrodynamic and reactive/diffusive instabilities in a dynamic model of liquid propellant combustion. Armstrong, R.C. (Sandia National Laboratories, Livermore, CA (USA)); Margolis, S.B. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

In a classical study of liquid propellant combustion, Landau introduced a simple model in which the liquid/gas interface was assumed to propagate normal to itself with constant velocity. Such a model, applied to the problem of premixed flame propagation, introduced the phenomenon of hydrodynamic flame instability, in which steady, planar deflagration was unstable to steady, but nonplanar (cellular), disturbances. For the case of liquid propellants, it was shown that the inclusion of gravitational and surface tension effects could suppress this phenomenon, whereas a later study due to Levich showed that the coupling of gravitational and viscous effects could produce a similar result. In the present work, the authors show that the assumption of a more realistic pyrolysis burning-rate law, which couples the temperature field to the problem, also is stabilizing with respect to hydrodynamic instability. In addition, this model admits a pulsating type of instability associated with the thermal sensitivity of the chemical reaction, analogous to that which exists for solid propellant combustion and the combustion synthesis of refractory materials. These results parallel recent developments in flame theory, which also suggest that the dynamic coupling of the burning rate with local conditions at the flame front can suppress Landau instability. In addition, however, the present work presents a closed-form expression for the dispersion relation, and predicts regions of stability for steady, planar burning with respect to both hydrodynamic and reactive/diffusive instabilities.

47698 The burning rate of hydroxylammonium nitrate-based liquid propellants. Vosen, S.R. (Sandia National Laboratories, Livermore, CA (USA)). pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

To improve the understanding of the physical processes which occur during the combustion of liquid propellants (LP), a strand burner was used to study hydroxylammonium nitrate-based LP flames. Combustion experiments were performed in which mixtures of the salts hydroxylammonium nitrate (HAN) and triethanolammonium nitrate (TEAN) in water were ignited by an electric discharge in a vessel at pressures of up to 30 MPa. The mixtures were contained in a strand burner that permitted visual observation of LP combustion at nearly constant pressure. Images of the combustion were obtained through windows in the pressure vessel by backlit photography, at a framing rate of 60 frames per second, with an exposure time of 100 microseconds. These images clearly showed the movement of a liquid-gas interface and a bright flame during LP combustion. Results of experiments conducted during turbulent combustion are: (1) the combustion of HAN-based LP occurs in two stages in which the liquid phase decomposition of HAN is followed by the decomposition of TEAN, (2) the turbulent combustion rate of LP 1846 decreases with increasing pressure. This variation of apparent burning rate with pressure, a result which is not seen in single component propellant combustion, is attributed to changes in the stability of the liquid-gas interface with pressure, and (3) a model of the combustion of HAN-based liquid propellants as it occurs in bulk has been presented, showing the reaction sequence of the components of HAN-based liquid propellants.

47699 A model for double base propellant combustion. Bizot, A. (ONERA, Chatillon (France)); Beckstead, M.W. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A model has been developed with a primary objective to develop a better understanding of the combustion mechanisms of double base propellants in both condensed and gas phases. The gas phase in double base propellants sustains two flames which are separated by a dark zone at low pressure. At high pressure, the secondary flame merges into the primary flame, eliminating the dark zone. The proposed model calculates the temperature profile in both the condensed phase and through both flames of the gas phase. The model solves the energy equations and species equations for both the condensed and gas phases separately, and then matches the boundary conditions between the two phases. The model solves the energy equations and species equations for both the condensed and gas phases separately, and then matches the boundary conditions between the two phases. The model assumes that there are three parallel reactions occurring in the condensed phase; a zero order degradation reaction, a first order reaction with NO_2, and a second order reaction of complex aldehyde species. The gas phase kinetics are summarized with four reactions; a first order NO_2 reaction, a second order reaction of aldehydes, a first order NO-carbon reaction, and a second order NO reduction reaction. Increasingly numerous experimental results (most from Kubota and Zenin) provide a well established data base which, along with increased computing capability, now allow one to verify the reliability of numerical models using a much broader variety of experimental data. A complete model must determine the burning rate as a function of pressure and initial temperature. In this study, the behavior of each reaction zone through the propellant combustion wave has been examined.

47700 High pressure combustion characteristics of RDX (cyclotrimethylene trinitramine) based propellants. Zhao, Baochang (East China Institute of Technology, Nanjing); Zhao, Zhijian. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The characteristics of RDX (cyclotrimethylene trinitramine) based propellant combustion over a wide range of pressure (5-430 MPa or 49-4250 atm) were studied experimentally. The data obtained from a strand burner and a closed bomb system show the influence of RDX concentration, particle size, the addition of NGD (nitroguanidine) and different binders used on the burning rate characteristics. It was found that the use of very fine RDX powder (2-3 μm) and the addition of a small concentration of NGD help to eliminate the pressure exponent shifts. The thermal analysis of the RDX based propellants with a Perkin-Elmer Corp. Differential Scanning Calorimeter, Model DSC-2C, and SEM examinations of quenched

propellant samples were conducted to study high pressure combustion mechanism of the nitramine propellants. The results revealed that the pressure exponent shifts of the RDX based propellants are related to the difference of decomposition of RDX and its binders, physical structure variation, burning surface change and chemical activation variation of N_2O with pressure.

47701 Linear fiber-optic array for measuring the transient propagation of a premixed-charged flame. Witze, P.O. (Sandia National Laboratories, Livermore, CA (USA)); Foster, D.E.; Kroeger, H. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A fiber-optic device for measuring the one-dimensional temporal motion of a freely propagating flame is described and demonstrated. The device uses a linear array of 16 optical fibers to collect and transmit light from a real image of the flame to photomultiplier tube detectors. A signal processor translates these signals into a single digital work that can be monitored by a dedicated computer at a 120 kHz rate. The most important feature of the device is the ability to record in real time the linear motion of very fast events. To demonstrate this device, simultaneous real-time measurements of flame position, two components of velocity, and pressure are made in the combustion chamber of a homogeneous-charge spark-ignition engine. Instantaneous values of flame speed are determined for the propagation of the flame along the diameter of a disk-shaped volume. Finally, the cycle-resolved measurements of gas velocity and flame speed are used to determine values for the turbulent burning velocity that are unbiased by cyclic variations in the combustion rate.

47702 SiC-based thin-filament pyrometry: Theory and thermal properties. Vilimpoc, V. (Systems Research Laboratories, Dayton, OH (USA)); Goss, L.P. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

Blackbody radiation from a thin filament of β-SiC can be used to measure the spatial temperature distribution in a combusting flowfield. The technique, Thin-Filament Pyrometry, exhibits rapid temporal response and excellent spatial resolution because of the small diameter and low thermal conductivity of the filament. Factors which affect the accuracy, temporal response, and spatial resolution of the probe in a H_2-N_2 jet diffusion flame are presented.

47703 Calculations of unsteady reacting droplet flows. Dwyer, H.A. (Univ. of California, Davis (USA)); Sanders, B.R. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The time-dependent history of a burning octane droplet has been computed. The purpose of the calculation is to understand the interplay between the transport phenomena, thermodynamics, and the chemical kinetics for a droplet decelerating from the initial Reynolds number condition of one hundred to a low Reynolds number flow near the end of the droplet lifetime. The results show that the drag and heat transfer characteristics are significantly different than those for an isothermal solid sphere, but that a semi-empirical drag correlation can adequately describe the computed results over most of the droplet lifetime. The heat transfer characteristics of the flow are not described well by a semi-empirical correlation, primarily due to the movement of the flame from the rear towards the forward stagnation region of the droplet.

47704 Unsteady flame propagation in a spray with transient droplet vaporization. Rangel, R.H. (Univ. of California, Irvine, CA (USA)); Sirignano, W.A. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A finite-difference solution of the problem of unsteady droplet vaporization and spray combustion in an idealized configuration consisting of parallel droplet streams is presented. A simplified flow field of uniform velocity is assumed in order to place particular attention on the mass and energy interactions between the fuel droplets and the gas flow. One-step finite-rate kinetics are employed so that an adequate description of the reaction zones and the mechanism of flame propagation can be obtained. Transient heating and drag acceleration of the droplets are taken into account. The transition from the initial conditions to the formation of the reaction zones is investigated. Individual envelope flames or group combustion can be observed depending on the flow parameters, mainly the separation between droplets. In general, a premixed reaction zone is formed which then acts as the ignition source for the droplets.

47705 Numerical study of multicomponent fuel spray flame propagation in a spherical closed volume. Continillo, G. (Univ. of California, Irvine (USA)); Sirignano, W.A. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The flame propagation through a fuel spray-air mixture in a spherical geometry is investigated by means of a one-dimensional, unsteady mathematical model with a hybrid Eulerian-Lagrangian formulation. Finite-difference numerical schemes are employed, with non-uniform grid spacing and adaptive time step. The solution applies to the whole extend of the propagation, giving an accurate description of the ignition and flame propagation towards the wall, until combustion is completed. Multi-component and polydisperse sprays are considered. Emphasis is given to: presence and role of diffusion and premixed flames; the movement of the droplets due to expansion of hot gases and the resulting stratification; the effect of rapid vaporization of more volatile components; and the influence of the droplet size on droplet time history in a spray flame. More volatile fuels produce faster flame propagation. Non-uniform vapor fuel composition is generated due to the different volatilities of the components of the liquid fuel spray. Increasing the droplet size causes strong local deviation from the initially uniform equivalence ratio, due to the relative motion of the two phases; fuel-rich and fuel-lean zones are present, and both premixed type and diffusion-type flames are observed at the same time.

47706 An investigation of combustion of boron suspensions. Li, S.C. (Princeton Univ. NJ (USA)); Williams, F.A.; Takahashi, F. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A steady nitrogen jet transporting fine ($0.04 \sim 0.15$ μ diameter) boron particles at low loading densities was injected coaxially into the hot combustion products of a flat-flame burner to study the kinetics of boron ignition and combustion. Three types of boron flame-plumes were found: a dark-yellow plume emitting dark-brown smoke from its tip, at measured maximum flat-flame temperatures below 1800 K; a yellow plume surrounded in its lower part by green emission, between approximately 1800 K and 1900 K. In these patterns, which were independent of the oxygen mole fraction in the product gas, over the range 0.08 to 0.80, the bright yellow was interpreted as boron ignition and the bright green as BO_2 emissions from boron combustion products. Based on a theory for a one-step, Arrhenius, ignition process, a theoretical analysis of the jet flow was employed to extract overall rate parameters from measurements of the height of the yellow plume as a function of the flat-flame temperature. The results were interpreted in terms of existing and new potential models for the ignition and combustion of boron particles.

47707 Spray-swirl interaction and early pyrolysis of kerosene and light oils spray flames produced by simplex pressure atomizer. Barbella, R. (Istituto di Ricerche sulla Combusione, Napoli (Italy)); Beretta, F.; Ciajolo, A.; D'Alessio, A.; Prati, M.V.; Tamai, R. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A comparative study of spray flame structures obtained with four light fuel oils having different viscosity and aromatic content has been carried out on pressure atomized sprays in isothermal and combustion conditions. The application of LLS and LDV techniques

on isothermal sprays coupled with the chemical analysis of condensed hydrocarbons and soot, collected into the corresponding flames, has shown the strong effect of the spray-swirl interaction on the flame structure. The controlling parameter on the flame structure for fixed swirl number and pressure atomization, when the chemical nature of the fuel is changed, has been found to be the fuel viscosity. The high viscosity fuel, generating a compact spray, not affected by the swirled air, burns as in a plug flow reactor undergoing just a slow evaporation along the flame axis. Soot and pyrolysis products are formed downstream in the flame. On the opposite the low viscosity fuel is dispersed radially in the outer regions of the spray; the recirculation of the air flow on the flame axis allows a rapid mixing that, in burning conditions, generates a flame similar to a partially stirred reactor. In these conditions soot and pyrolysis products formation occurs already in the first region of the flame in spite of the low aromaticity of the fuel. PAH and polar aromatic compounds have shown to be the best signature for the degree of pyrolysis and oxidation reaction which the fuel undergoes.

47708 **Droplet dispersion and transport mechanisms in a turbulent, free shear-layer.** Lazaro, B.J. (Univ. of Southern California, Los Angeles (USA)); Lasheras, J.C. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

This paper reports an experimental study of a plane, two-dimensional, turbulent mixing layer formed between a one-dimensional uniform liquid spray and a stagnant air flow. Flow visualization as well as light scatter and laser diffraction techniques are used to measure the growth rate, density and droplet size distribution across the mixing layer. It is shown that the mechanism of mass and momentum transfer between the phases (droplet dispersion) is dominated by the presence of a large, coherent, two-dimensional vortical structure formed through the primary shear instability. Measurements of mean Sauter Mean Diameter (SMD) across the mixing layer show that these large vortices, which dominate the features of the flow, control not only the entrainment of irrotational air into the spray but, more importantly, they determine the density and distribution of droplet sizes throughout the mixing region.

47709 **An experimental investigation of the incineration and incinerability of chlorinated alkane droplets.** Sorbo, N.W. (Univ. of California, Davis (USA)); Law, C.K.; Chang, D.P.Y.; Steeper, R.R. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

An experimental investigation has been conducted on the vaporization, combustion, and extinction of droplets of pure chlorinated alkanes and their mixtures with n-alkanes in inert and oxidizing environments. From results on the droplet vaporization/combustion rates, the state of extinction, and temporal changes in the droplet composition, it is shown that droplets of lightly chlorinated alkanes as represented by monochloroalkanes burn almost as vigorously as normal alkanes, that heavily chlorinated alkanes as represented by 1, 1, 2, 2-tetrachloroethane (TECA) burn weakly if at all, that TECA can be rendered to burn vigorously with the addition of only 25 volume percent of an equal-volatility alkane, and that this enhancement can be further improved by decreasing the volatility of the additive. Implications on hazardous waste incineration are discussed.

47710 **Observations on the low temperature vaporization and envelope or wake flame burning of n-heptane droplets at reduced gravity during parabolic flights.** Gokalp, I. (Centre National de la Recherche Scientifique, Orleans (France)); Chauveau, C.; Richard, J.R.; Kramer, M.; Leuckel, W. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A Droplet Burning Facility which allows the investigation of droplet vaporization and burning under various dynamic and thermal conditions has been constructed. The system has been operated during the parabolic flights of the NASA KC135 aircraft. An important set of data has been collected on the low temperature vaporization and envelope or wake flame burning of suspended n-heptane droplets at reduced gravity conditions. From digitized images delivered by a rapid video camera, the time evolution of the droplet and the flame dimensions are determined with great accuracy. This information is used to deduce the vaporization rate, the flame diameter and the flame standoff ratio under various conditions. The evolution of these parameters is compared to that on normal gravity conditions obtained with the same apparatus. The Reynolds number dependency of the vaporization rate under reduced and normal gravity conditions is also discussed.

47711 **The combustion of unsupported heptane/hexadecane mixture droplets at low gravity.** Yang, J.C. (Cornell Univ., Ithaca, NY (USA)); Avedisian, C.T. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). DOE Contract AC02-83ER13092. From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The results of an experimental study of the effect of fuel composition on burning of unsupported droplets in a reduced gravity environment are reported. The liquids studied were mixtures of heptane and hexadecane. The experiments were conducted in a drop tower which provided an experimental observation time of about 1.2 s. The experimental technique consisted of projecting a test droplet within a closed container in a near vertical trajectory and then releasing a camera positioned at the apex of the droplet's trajectory, the combustion chamber containing the droplet, and associated instrumentation into free fall when the droplet reached the apex. In this way the test droplet was effectively captivated with respect to the moving frame of reference. Some droplets occasionally drifted with respect to the camera during free fall, and this motion corresponded to a droplet Reynolds number of the order of .01 or smaller. The evolution of droplet diameter was similar to that of the classical d^2 law, though with some evidence of droplet heating and extinction being revealed for some of the liquids. Microexplosions were not observed for the range of compositions studied.

42 ENGINEERING

4202 Facilities and Equipment

Refer also to citation(s) 47109, 47191, 47192, 47193, 47194, 47195, 47196, 47198, 47243, 47386, 47389, 47763

47712 (AD-A-207235/3/XAB) **MM & T for linear resonant cooler. Volume 1. Final report, October 1984-September 1986.** Narayan, R.; Silvestro, J. Magnavox Government and Industrial Electronics Co., Mahwah, NJ (USA). Electro-Optical Systems. 16 Feb 1988. 111p. (EOSR-1608-VOL-1). Available from NTIS, PC A06/MF A01.

See also Volume 2, AD-A207 236.

The three-fold objectives of this contract were to: (1) enhance the producibility and performance of the prototype cooler design developed in a prior contract, (b) qualify the design to the target specification in the contract (basically the HD1045/UA B2 specification amended for 2,500 hour MTTF and low audible noise), and (c) develop and demonstrate a pilot production facility for the cooler. Technical difficulties and cost growth related to objectives (a) and (b) above precluded accomplishing (c) as part of this contract's activities. Nevertheless, performance within or exceeding all major requirements has been demonstrated, and the company is currently producing the cooler for use on a U.S. Air Force airborne IR system.

47713 (AD-A-207333/6/XAB) **High-temperature ceramic superconductors. Report for 1 January-31 March 1989.** Mazdiyasni, K.S.; Chen, K.C.; DeHope, W.J.; Lin-Liu, Y.R.; McQuillan, B.W. General Atomics, San Diego, CA (USA). 10 Apr 1987. 70p. Available from NTIS, PC A04/MF A01.

This is the third quarterly progress report on the work performed in the period from January 1, 1989 through March 31, entitled High-Temperature Ceramic Superconductors. The principal objectives of this program are (1) to demonstrate fabrication of high-temperature ceramic superconductors that can operate at or above 90 K with appropriate current density, Jc, in forms useful for application in resonant cavities, magnets, motors, sensors, computers, and other

devices; and (2) to fabricate and demonstrate selected components made of these materials, including microwave cavities and magnetic shields.

47714 (AD-A–207395/5/XAB) **Statement on superconductivity.** Kerber, R.L. Department of Defense, Washington, DC (USA). 7 Oct 1987. 8p. Available from NTIS, PC A02/MF A01.

Recent advances in high-temperature superconductivity offer the Department of Defense opportunities for enhancing our national security through expansion of capabilities of existing weapons and support systems, and through development of new generations of systems yet to be conceived. It is possible that military systems with superconducting features will constitute a key area of future technological competition with our adversaries. While it is difficult to foresee the full national security implications of superconductivity given the knowledge at hand, the Department should and will devote substantial resources to this new, dynamic, and important technology. In accord with the President's superconductivity initiative, the Department plans to spend $150 million on superconductivity R&D over the next three years. The US DOD intends to accommodate this level of effort within the President's budget.

47715 (AD-A–207412/8/XAB) **Environmental test report on the CTI-Cryogenics 1-watt integral Stirling cooler (long-life HD-1033d). Final report, 16 June-24 July 1988.** Doggett, G.; Dunmire, H.; Samuels, R.; Shaffer, J. Army Center for Night Vision and Electro-Optics, Fort Belvoir, VA (USA). Apr 1989. 105p. (AMSEL-NV-TR–0077). Available from NTIS, PC A06/MF A01.

This final report describes and provides the data on the environmental testing of the CTI-Cryogenics 1-Watt Integral Stirling Cooler (Long-Life HD-1033D). The 1-Watt Integral Cooler (HD-1033B/C) is currently used in the M1 FLIR, M60 FLIR, and the Advanced Attack Helicopter FLIR. The long life cooler (clearance seal) improves life of the cooler by approximately two and one half times. C2NVEO evaluated the cooler performance at environmental extremes per the purchase description, PD-0182-001(CR). The cooler successfully passed all the environmental tests with no failures.

47716 (CONF-890781–3) **On estimation of uncertainties in analog measurements.** Adibi, M.M.; Stovall, J.P. Oak Ridge National Lab., TN (USA). [1989]. 7p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC05-84OR21400. From IEEE summer power meeting; Long Beach, CA (USA); 9-14 Jul 1989. Order Number DE89016858/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Computer control of power systems requires evaluation of uncertainties in analog measurements and their reduction to a level that allows satisfactory control. In this paper a range of measurements is obtained from a substation to span peak- and light-load conditions and to include bus voltages, phase angles and line flows. Then the redundancies in measurements are used to formulate several functions relating these measurements with their attending errors. Minimization of these functions have yielded the required corrective coefficients. 6 refs., 1 fig., 6 tabs.

47717 (DOE/CE/15290–T1) **Vacuum heat training furnace: Final technical report.** Stainbrook, N.E. Stainbrook Engineering, Meadville, PA (USA). 10 Jul 1989. 42p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-86CE15290. Order Number DE89016795/JAW. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

This is the final technical report for the project. The project is the development of a small thermal processing device for metals. The design, build, and functional testing of the Marketable Prototype Unit was funded by a grant under the Department of Energy's Energy-Related Inventions Program (ERIP). The unit is a small vacuum heat treating furnace system – with liquid quench capabilities – for processing a single part or a small lot. Tests and operation of prototype units have demonstrated that the system is suitable for use with either water or oil as the liquid quench medium. In addition, furnace cooling, controlled slow cooling, and delayed quench are also available options.

47718 (DOE/ER/13329–3) **A design and synthesis procedure for homogeneous and heterogeneous azeotropic distillations: Final report, March 1, 1985–February 29, 1988.** Doherty, M.F. Massachusetts Univ., Amherst, MA (USA). Dept. of Chemical Engineering. Feb 1988. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-85ER13329. Order Number DE89017513/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

New design and synthesis techniques have been developed for two types of complex multicomponent distillation systems; heterogeneous distillations, and reactive distillations. The concepts of residue curve maps and distillation boundaries have been extended to these systems. On the basis of these tools it is possible to distinguish between feasible and infeasible separations. This is the cornerstone of the synthesis procedure. For reactive mixtures, a new set of transformed composition variables have been invented which have the remarkable property of making reactive separations appear almost identical to non-reactive systems. Thus many of the techniques which have been developed for non-reactive mixtures are applicable to reactive systems, provided the transformed variables are used. 6 refs.

47719 (LA-UR–89-2671) **Air breakdown photography in the picosecond domain.** Kyrala, G.A.; Lee, P.H.Y.; Stetler, K.A.; Yu, I.I.K. Los Alamos National Lab., NM (USA). 1989. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-890836–12: 33. SPIE annual international technical symposium on optical and optoelectronic applied science and engineering, San Diego, CA (USA), 6-11 Aug 1989). Order Number DE89016775/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We have studied the breakdown of air using the Los Alamos Bright Source KrF laser at an irradiance of 1.36×10^{16} W/cm^2 and pulse length of 700 fs. Results of the temporal evolution of various regions of the spark, recorded with an S-20 streak/framing camera, are presented. 14 refs., 6 figs.

47720 (N–89-21239) **Advanced helium purge seals for Liquid Oxygen (LOX) turbopumps. Final report, September 1985-August 1987.** Shapiro, W.; Lee, C.C. Mechanical Technology, Inc., Latham, NY (USA). Mar 1989. 175p. (NASA-CR–182105;NAS–1.26:182105;MTI–87TR72). Available from NTIS, PC A08/MF A01.

Program objectives were to determine three advanced configurations of helium buffer seals capable of providing improved performance in a space shuttle main engine (SSME), high-pressure liquid oxygen (LOX) turbopump environment, and to provide NASA with the analytical tools to determine performance of a variety of seal configurations. The three seal designs included solid-ring fluid-film seals often referred to as floating ring seals, back-to-back fluid-film face seals, and a circumferential sectored seal that incorporated inherent clearance adjustment capabilities. Of the three seals designed, the sectored seal is favored because the self-adjusting clearance features accommodate the variations in clearance that will occur because of thermal and centrifugal distortions without compromising performance. Moreover, leakage can be contained well below the maximum target values; minimizing leakage is important on the SSME since helium is provided by an external tank. A reduction in tank size translates to an increase in payload that can be carried on board the shuttle. The computer codes supplied under this program included a code for analyzing a variety of gas-lubricated, floating ring, and sector seals; a code for analyzing gas-lubricated face seals; a code for optimizing and analyzing gas-lubricated spiral-groove face seals; and a code for determining fluid-film face seal response to runner excitations in as many as five degrees of freedom. These codes proved invaluable for optimizing designs and estimating final performance of the seals described.

47721 (PB–89-865257/XAB) **Sensors and detectors based on superconducting devices. January 1970-June 1988 (Citations from the COMPENDEX data base). Report for January 1970-June 1988.** National Technical Information Service, Springfield, VA (USA). Jul 1989. 168p. Available from NTISPC N01/MF N01.

See also PB–89-865265.

This bibliography contains citations concerning gradiometers, magnetometers, and infrared detectors which use superconductors to improve sensitivity. Applications include biomagnetic measurements for medical studies, gravity-wave experiments, geomagnetism and ocean-bottom magnetic exploration, galvanometers and voltmeters, and bolometers and radiometers. Some articles refer to

design considerations for cooling systems for the sensors and detectors, and fabrication techniques for SQUIDs (superconducting quantum interference devices.) (This updated bibliography contains 394 citations, none of which are new entries to the previous edition.)

47722 (PB–89-865265/XAB) **Sensors and detectors based on superconducting devices. July 1988-June 1989 (Citations from the COMPENDEX data base). Report for July 1988-June 1989.** National Technical Information Service, Springfield, VA (USA). Jul 1989. 45p. Available from NTISPC N01/MF N01.

Supersedes PB–88-866538. See also PB–89-865257.

This bibliography contains citations concerning gradiometers, magnetometers, and infrared detectors which use superconductors to improve sensitivity. Applications include biomagnetic measurements for medical studies, gravity-wave experiments, geomagnetism and ocean-bottom magnetic exploration, galvanometers and voltmeters, and bolometers and radiometers. Some articles refer to design considerations for cooling systems for the sensors and detectors, and fabrication techniques for SQUIDs (superconducting quantum interference devices.) (This updated bibliography contains 74 citations, all of which are new entries to the previous edition.)

47723 (SAND–89-0547) **Rethinking synthesis of fine-motion strategies.** Strip, D. Sandia National Labs., Albuquerque, NM (USA). 2 Jun 1989. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE89016671/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In their influential paper, "Automatic Synthesis of Fine-Motion Strategies for Robots," Lozano-Perez, Mason, and Taylor hypothesize that fine-motion strategies are inherently dependent on fine details of part geometry. They propose a complex algorithm which accounts for fine details in developing fine-motion strategies. Recent work on insertions and grasping suggests that the use of force-directed strategies allows the development of robust action primitives that are independent of all but the grossest details of geometry. 14 refs., 3 figs.

47724 (SAND–89-1256) **Land vehicle teleoperation under conditions of reduced video resolution.** Schoeneman, J.L.; McGovern, D.E. Sandia National Labs., Albuquerque, NM (USA). Aug 1989. 60p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE89016925/JAW. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

Teleoperation of land vehicles was studied to investigate the effects of both spatial and temporal video resolution on the ability of the operator to effectively control the vehicle. Teleoperation extends part of a human operator's presence into remote or hazardous areas, and the predominant form of sensory feedback is that of vision. The quality of the transmitted video information has a significant effect on the operator's confidence and ability to effectively control the vehicle. Experiments were constructed to allow subjective evaluation of the lower limits of video quality necessary for degraded, yet effective, Teleoperation. Subjects were asked to teleoperate a remote vehicle under varying conditions to degraded spatial and temporal resolution, and their comments were recorded along with the video driving scenes during teleoperation. Subjective assessments and teleoperation test data suggest the possibility of reducing the required video bandwidth for teleoperation by a factor of 28:1 over normal video standards. 9 refs., 18 figs., 9 tabs.

47725 (SAND–89-1964C) **Techniques for recovery of shock-loaded samples.** Dodson, B.W.; Boslough, M.B. Sandia National Labs., Albuquerque, NM (USA). 1989. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-890812–41: American Physical Society topical conference on shock compression of condensed matter, Albuquerque, NM (USA), 14-17 Aug 1989). Order Number DE89016881/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Recovery of impact loaded samples is extremely difficult owing to the highly destructive post-shock environment. A variety of techniques have been introduced to accomplish this task for both organic and inorganic samples. The design principles underlying these techniques and the practical limitations encountered in applications are described. 3 figs.

47726 (UCRL–100270) **The characterization of Nb_3Sn superconductors for use in magnets of 19 T and greater.** Summers, L.T.; Strum, M.J.; Miller, J.R. Lawrence Livermore National Lab., CA (USA). 8 Aug 1989. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-890701–5: International cryogenic materials conference, Los Angeles, CA (USA), 24-28 Jul 1989). Order Number DE89017758/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Increased resolution of NMR spectrometry will require the use of very high field Nb_3Sn superconducting magnets. Here we report the results of our investigation into mechanical and temperature effects on internal-Sn superconductors similar to those proposed for use in a 900 MHz, 21 T NMR magnet system. Thermal precompression was found to be about 0.225%, and the irreversible strain was about 0.8%. Fatigue degradation was not observed at cyclic intrinsic strains below 0.575%. Additions of reinforcing steel in cable conductors was found to reduce the critical current by as much as 50% compared to similar, unreinforced cables. Reduction of the testing temperature to 2.3 K did not increase the critical current in steel-reinforced cables to a level significantly above that of unreinforced samples. 4 refs., 3 figs., 1 tab.

47727 (UCRL–100357-Rev.1) **Subnanosecond linear GaAs photoconductive switching: Revision 1.** Druce, R.L.; Pocha, M.D.; Griffin, K.L.; Hofer, W.W. Lawrence Livermore National Lab., CA (USA). 1989. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890665–48-Rev.1: 7. Institute of Electrical and Electronics Engineers pulsed power conference, Monterey, CA (USA), 12-14 Jun 1989). Order Number DE89017739/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We are conducting research in photoconductive switching for the purpose of generating subnanosecond pulses in the 25–50kV range. We are exploiting the very fast recombination rates of Gallium Arsenide (GaAs) to explore the potential of GaAs as a closing and opening switch when operating in the linear mode (the linear mode is defined such that one carrier pair is generated for each photon absorbed). The closing time of a linear GaAs switch is theoretically limited by the characteristics of the laser pulse used to activate the switch (the carrier generation time in GaAs is $\sim 10^{-14}$ sec) while the opening time is theoretically limited by the recombination time of the carriers. The recombination time is several ns for commercially available semi-insulating GaAs. Doping or neutron irradiation can reduce the recombination time to less than 100 ps. We have observed switch closing times of less than 200 ps with a 100 ps duration laser pulse and opening times of less than 400 ps with neutron irradiated GaAs at fields of tens of kV/cm. The illumination source was a Nd:YAG laser operating at 1.06 μm. 4 refs., 11 figs.

47728 (UCRL–100403) **Design and performance of an optical mount using cross-flexure pivots.** Rundle, W.J. Lawrence Livermore National Lab., CA (USA). 1 Jul 1989. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890836–13: 33. SPIE annual international technical symposium on optical and optoelectronic applied science and engineering, San Diego, CA (USA), 6-11 Aug 1989). Order Number DE89017551/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The design of an optical mount using commercially available cross-flexure steel pivots is described. The pivots and their incorporation into a 5- x 10-inch rectangular optical mount are illustrated. Test data on this mount show acceptable thermal stability and thermal hysteresis for use in a laboratory optical system. The design is easily scaled to other optic sizes. 9 refs., 5 figs., 1 tab.

47729 (UCRL–101777) **Benchmarking of the computer code and the thirty foot side drop analysis for the Shippingport RPV/NST package.** Bumpus, S.E.; Gerhard, M.A.; Hovingh, J.; Trummer, D.J.; Witte, M.C. Lawrence Livermore National Lab., CA (USA). Jun 1989. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890601–2: Packaging and transportation of radioactive materials: PATRAM '89, Arlington, VA (USA), 11-16 Jun 1989). Order Number DE89017891/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper presents the benchmarking of a finite element computer code and the subsequent results from the code simulating the

30 foot side drop impact of the RPV/NST transport package from the decommissioned Shippingport Nuclear Power Station. The activated reactor pressure vessel (RPV), thermal shield, and other reactor external components were encased in concrete contained by the neutron shield tank (NST) and a lifting skirt. The Shippingport RPV/NST package, a Type B Category II package, weighs approximately 900 tons and has 17.5 ft. diameter and 40.7 ft. length. For transport of the activated components from Shippingport to the burial site, the Safety Analysis Report for Packaging (SARP) demonstrated that the package can withstand the hypothetical accidents of DOE Order 5480.3 including 10 CFR 71. Mathematical simulations of these accidents can substitute for actual tests if the simulated results satisfy the acceptance criteria. Any such mathematical simulation, including the modeling of the materials, must be benchmarked to experiments that duplicate the loading conditions of the tests. Additional confidence in the simulations is justified if the tests specimens are configured similar to the package. 7 refs., 2 figs., 1 tab.

47730 SNRS [stationary neutron radiography system] component positioning systems. Alvar, K.R. (SAIC, San Diego, CA (USA)); Brown, K.G.; Maung, T.; Meier, M.S.; Orphan, V.J. *Transactions of the American Nuclear Society (USA),* 55: 675-676 (1987). (CONF-8711195--: American Nuclear Society winter meeting, Los Angeles, CA (USA), 15-19 Nov 1987).

This paper discusses the stationary neutron radiography system (SNRS) with respect to the component positioning systems (CPSs) and the rationale behind their design. As design work is on-going at science Applications International Corporation, this report gives a current update of progress. The SNRS has four separate radiography bays, Bays 1 through 4. The first three bays have automated positioning systems for real-time and near real-time neutron radiography of aircraft components. Bay 4 has been designed to accommodate components from the solid rocket booster, but will be used first for film radiography of pyrotechnic components.

47731 Robotic delivery system for plasma cutting of the TMI-2 [Three Mile Island Unit 2] lower core support assembly. McGough, M.S.; Austin, W.E.; Kwech, H.; Litka, T.J. *Transactions of the American Nuclear Society (USA),* 55: 679-680 (1987). (CONF-8711195--: American Nuclear Society winter meeting, Los Angeles, CA (USA), 15-19 Nov 1987).

An effort is currently under way at Three Mile Island Unit 2 (TMI-2) to provide equipment to defuel the region of the reactor vessel below the core. To access this area, a stainless steel structure called the lower core support assembly (LCSA) must be removed. Photographs of this region show it to be undamaged by the accident. As one of several options, the plasma arc cutting process has been selected as the primary method with which to section the LCSA to provide large openings for debris removal from the region. Sectioned pieces of the LCSA must be of a manageable size and must fit into debris canisters for ultimate removal from the vessel. Power Cutting, Inc., under contract to GPU Nuclear, has engineered, fabricated, and tested an automated cutting equipment system (ACES) to conduct the cutting of the LCSA. The cutting system will include plasma arc cutting, rotary grinding, and abrasive water jetting. It will be a system consisting of a support frame, movable carriage, and trolley for horizontal x,y direction control, and a movable vertical z axis robotic telescoping arm supported on the trolley/carriage arrangement. The support frame, carriage, trolley, and robotic arm will be set on and above the LCSA, submerged in ≈35 ft of reactor coolant. It will be remotely operated and controlled.

47732 Fine filament NbTi conductors for the SSC. Kanithi, H.C. (IGC/Advanced Superconductors, Inc., 1875 Thomaston Avenue, Waterbury, CT (US)); King, C.G.; Zeitlin, B.A.; Scanlan, R.M. *IEEE (Institute of Electrical and Electronics Engineers) Transactions on Magnetics (USA),* 25(2): 1922-1925 (Mar 1989). (CONF-880812--: Applied superconductivity conference, San Francisco, CA (USA), 21-25 Aug 1988).

In support of the SSC magnet development program, IGC-Advanced Superconductors, Inc. has produced over 4500 lbs of fine filament wire. Since the SSC would require a large volume production at the most economical price, billets measuring 12" dia have been used for this prototype wire production. Both inner and outer grades of wire have been processed with NbTi filament diameters of 5 to 9 micrometers, depending on the magnet design requirements. The increase in billet diameter from 10" in the past to 12" resulted in an improved critical current density approaching 3000 A/mm^2 at 5T. This paper reports on the electrical properties (J_c and n value) and mechanical properties (tensile, springback and bend characteristics) of the strand. Piece length distribution obtained for various production billets is presented. The performance of cables fabricated from the strand is discussed. Specifically, the critical current degradation due to cabling and residual twist in the cable is addressed.

47733 Superconducting shielded PYX PPM stacks. Leupold, H.A. To Department of the Army, Washington, DC. USA Patent 7-335,649. 7 Apr 1989. 17p. Available from NTIS, PC A03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

Periodic permanent-magnet structures comprise a plurality of paired axially aligned segments of transversely sliced or truncated hollow cylindrical flux sources, each of which produces a uniform high field in its central cavity. Each pair of segments is mounted on opposite sides of a respective plate of permeable material. The magnetic-field orientations in the central cavities are axially directed and alternate or reverse in direction from segment to segment. An axial bore hole drilled through the segments and plates provides a continuous channel or path through which the beam of charged particles will travel.

47734 Superconducting shielded PYX PPM (periodic permanent magnet) stacks. Leupold, H.A. To Department of the Army, Washington, DC. USA Patent 7-327,931. 23 Mar 1989. 15p. Available from NTIS, PC A03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

Periodic permanent magnet structures comprise a plurality of segments of transversely sliced or truncated hollow cylindrical flux sources each of which produces a uniform high-field in its central cavity. Each flux source has an axial tunnel through its magnetic poles. The sources are arranged linearly with adjacent flux sources in peripheral edge contact with their magnetic fields in alignment so as to form a continuous channel through which a beam of charged particles can travel. Superconducting sheets cover the end faces of each of the sliced flux sources. Patent applications. (RH)

47735 Method of transforming a passive ferromagnetic material into a permanent magnet. Leupold, H.A. To Department of the Army, Washington, DC. USA Patent 7-326,777. 20 Mar 1989. 8p. Available from NTIS, PC A02/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

A passive ferromagnetic material is transformed into a permanent magnet with more than double the existing energy product or strength by encasing a bar of the passive ferromagnetic material in an annular shell of superconductive material at a temperature above the transition temperature of the superconductive material, placing the encased ferromagnetic material into an axial magnetic field providing sufficient oersteds to magnetize the passive ferromagnetic material thereby enclosing a large amount of flux in the superconducting shell, lowering the temperature to below the transition temperature of the superconductive material whereupon all of the enclosed flux is permanently trapped, and removing the axial magnetic field.

47736 Method of mass-producing superconducting persistent current rings. Leupold, H.A. To Department of the Army, Washington, DC (USA). USA Patent 7-322,381. 13 Mar 1989. 9p. Available from NTIS, PC A02/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

Superconducting persistent current rings are mass produced by passing each superconducting ring through a tapered magnetic field that is tapered in strength so that, when each ring passes through the maximum magnetic field of the tapered magnetic field above the critical field of the tapered magnetic field, the superconducting ring becomes normal thereby admitting all of the flux to which its cross section is exposed. When the ring is passed to a region of field lower in strength than the critical field, the ring becomes superconducting again and traps the flux to which its cross section is exposed.

4203 Lasers

Refer also to citation(s) 47846, 48271, 48462

47737 (AD-A–204228/1/XAB) **Spatial and frequency dependence of four-wave mixing in broad-area diode lasers.** Luchente, M.; Fujimoto, J.G.; Carter, G.M. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. 14 Nov 1988. 4p. (JA–6148). Available from NTIS, PC A02/MF A01.

Pub. in Applied Physics Letter, Vol. 53, No. 20, 1897-1899(14 Nov 1988).

By injecting two external optical beams into a broad-area laser diode, four-wave mixing is generated via gain nonlinearities in the device. The nonlinear signals are observed by spectrally analyzing the transverse far-field profile of the emission from the device. By varying the injection angle and oscillation wavelength of one of the injected beams, the spatial and frequency dependence of this nonlinear process is measured. The results support a spatially dependent dynamic carrier concentration model which includes the effects of carrier diffusion. These measurements provide a direct determination of the ambipolar diffusion constant in the device D - 9.5 sq.cm/s. Keywords: Diode lasers; External optical beams; Nonlinear signal; Reprints. (jhd)

47738 (AD-A–205471/6/XAB) **Summaries of papers presented at the short-wavelength coherent radiation: Generation and applications topical meeting held in Cape Cod, Massachusetts on September 26-29, 1988. Final report, 9 March 1988-1 March 1989.** Quinn, J.W. Optical Society of America, Washington, DC (USA). 1 Mar 1989. 166p. Available from NTIS, PC A08/MF A01.

The meeting dealt with the development and application of sources of coherent radiation from the extreme-ultraviolet to the x-ray spectral region. Closely related areas of interest are multiphoton phenomena, soft x-ray optics, and laser-produced plasmas. Topics covered included: short-wavelength lasers, free electron lasers and undulators, harmonic generation and frequency conversion, short-wavelength optics and novel instrumentation, laser plasma radiation sources, multiphoton phenomena, ultrafast short-wavelength sources, applications in spectroscopy, microscopy, and microfabrication, phase coherent applications, holography and interferometry, and unique applications of short-wavelength sources.

47739 (AD-A–207261/9/XAB) **Transverse pumping with diode lasers. Technical report.** Treacy, E.B. Thermo Electron Technologies Corp., San Diego, CA (USA). 6 Jan 1989. 86p. (TTC–1529-R). Available from NTIS, PC A05/MF A01.

The transverse pumping of a cylindrical laser rod such as YAG by a set of diode laser arrays equally spaced in angle around the rod was analyzed using both geometrical and wave optics. Between the pump sources and the laser rod there may be an arbitrary number of concentric media, transparent to the pump light; and, in addition, modification of the diode-laser radiation patterns will require other optical components. The analysis accommodates both of these complications, even when the optics in front of the diodes do not image point sources to points. It is sufficient to be able to describe the intensity and ray directions in finite apertures concentric with the rod. One result of the cylindrical geometry is the formation of caustics that have infinite intensity in the geometrical optics approximation; and it is necessary to develop a wave optics theory to predict the intensity in the neighborhood of the caustic edge of the illuminated region inside the laser rod. The wave theory first uses the geometrical optics method to calculate the amplitude and phase just inside the rod's surface, which serves then as an aperture distribution function describing the source of Huygens wavelets in the computation of a diffraction integral.

47740 (AD-A–207569/5/XAB) **High power semiconductor laser sources. Final report.** Yariv, A. California Inst. of Tech., Pasadena, CA (USA). 1989. 93p. Available from NTIS, PC A05/MF A01.

The main purpose of the research was to design and fabricate a surface-emitting semiconductor laser based on multi quantum-well amplification. During the contract period, the author succeeded in improving the basic quantum-well active medium so as to result in maximum gain for a given inversion density and analyzed the fabrication of GaAs/GaAlAs multilayer dielectric reflectors for providing the optical feedback to the surface-emitting semiconductor laser. He also made significant progress in the development of diffusion techniques to provide the p and n regions adjacent to the active region for carrier injection.

47741 (DOE/ER/13973–1) **Nonlinear dynamics of broadband lasers: Progress report, September 1, 1988–August 31, 1989.** Raymer, M.G. Oregon Univ., Eugene, OR (USA). Dept. of Physics. Jun 1989. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract FG06-88ER13973. Order Number DE89017442/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Progress has been made on two fronts. First, a Ti:Sapphire laser and a micro-cavity dye laser have been designed and constructed, and are now being tested. Second, a theoretical analysis has been carried out on the effects of quantum noise on multimode lasers operating just above threshold. The prediction is that as threshold is approached from above, the mode intensity correlation time increases to a maximum value and then decreases when the quantum noise becomes dominant near threshold. We plan to observe these effects in our studies. 2 refs.

47742 (DOE/ER/25019–11) **Nonlinear resonance: Annual report.** Kevorkian, J. Washington Univ., Seattle, WA (USA). 1989. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract FG06-86ER25019. Order Number DE89017270/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report discusses the dynamics of a free-electron laser with a variable parameter wiggler, and resonance in oscillatory systems with slowly varying parameters. 8 refs., 2 figs., (LSP)

47743 (LA-UR–89-2867) **Minimized emittance growth with elliptical beam pipes in FEL [free-electron-laser].** Chan, K.C. Los Alamos National Lab., NM (USA). 1989. 17p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-8908134–2: 11. international free electron laser conference, Naples, FL (USA), 28 Aug - 1 sep 1989). Order Number DE89016982/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Wakefield effects can cause emittance growth in free-electron-laser systems and reduce free-electron-laser gain. This paper explains that, by using beam pipes with elliptical cross sections, discontinuities can be allowed along a beam pipe without introducing wakefields. To use a beam pipe with an elliptical cross section, wakefield-less transitions between beam pipes with circular and elliptical cross sections are also needed. A concept to achieve such a transition is discussed. 4 refs., 7 figs.

47744 (LA-UR–89-2915) **Stability requirements of rf linac-driven free-electron lasers.** Stein, W.E.; Johnson, W.J.D.; Power, J.F.; Russel, T.J. Los Alamos National Lab., NM (USA). [1989]. 15p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-8908134–4: 11. international free electron laser conference, Naples, FL (USA), 28 Aug - 1 sep 1989). Order Number DE89016609/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Fluctuations in the output power and wavelength have been observed in two high-power, rf-driven, free-electron lasers (FELs): the 10-μm FEL that has operated at the Los Alamos National Laboratory and the visible FEL at the Boeing Physical Sciences Research Center. The fluctuations have been traced primarily to instabilities in the electron beam. Specifically, these are variations in the electron energy, the charge per micropulse, and the time interval between micropulses. The effects of these instabilities on the performance of one of the FELs is demonstrated. Efforts made to minimize these instabilities are discussed and the subsequent improvements in the operation of each of the FELs are presented. 7 refs., 7 figs.

47745 (N–89-19539) **Nonradiative relaxation and laser action in tunable solid state laser crystals. Final technical report, 1 September 1987-31 December 1988.** Petricevic, V.; Gayen, S.K.; Alfano, R.R. City Coll., New York, NY (USA). Mar 1989. 9p. (NASA-CR–182820;NAS–1.26:182820). Available from NTIS, PC A02/MF A01.

Room-temperature pulsed laser action was obtained in chromium-activated forsterite (Cr:Mg2SiO4) for both 532 and 1064 nm pumping. Free running laser emission in both cases is centered at

1235 nm and has a bandwidth of approximately 30 nm. Slope efficiency as high as 22 percent was measured. Using different sets of output mirrors and a single birefrigent plate as the intracavity wavelength selecting element tunability over the 1167 to 1268 nm spectral range was demonstrated. Continuous wave laser operation at room temperature was obtained for 1064 nm pumping from a CW Nd:YAG laser. The output power slope efficiency is 6.8 percent. The gain cross section is estimated to be 1.1 x 10 to the 19th sq cm. Spectroscopic studies suggest that the laser action is due to a center other than the trivalent chromium (Cr 3+), presumably the tetravalent chromium (Cr 4+) in a tetrahedrally coordinated site.

47746 (N–89-20447) **Direct solar-pumped iodine laser amplifier. Semiannual progress report, 1 September 1988-28 February 1989.** Han, K.S.; Hwang, I.H.; Stock, L.V. Hampton Inst., VA (USA). Feb 1989. 30p. (NASA-CR–184813;NAS–1.26:184813). Available from NTIS, PC A03/MF A01.

This semiannual progress report covers the period from September 1, 1988 to February 28, 1989 under NASA grant NAG-1-441 entitled, Direct Solar-Pumped Iodine Laser Amplifier. During this period, the research effort was concentrated on the solar pumped master oscillator power amplifier (MOPA) system using n-C3F7I. In the experimental work, the amplification measurement was conducted to identify the optimum conditions for amplification of the center's Vortek solar simulator pumped iodine laser amplifier. A modeling effort was also pursued to explain the experimental results in the theoretical work. The amplification measurement of the solar simulator pumped iodine laser amplifier is the first amplification experiment on the continuously pumped amplifier. The small signal amplification of 5 was achieved for the triple pass geometry of the 15 cm long solar simulator pumped amplifier at the n-C3F7I pressure of 20 torr, at the flow velocity of 6 m/sec and at the pumping intensity of 1500 solar constants. The XeCl laser pumped iodine laser oscillator, which was developed in the previous research, was employed as the master oscillator for the amplification measurement. In the theoretical work, the rate equations of the amplifier was established and the small signal amplification was calculated for the solar simulator pumped iodine laser amplifier. The amplification calculated from the kinetic equations with the previously measured rate coefficients reveals very large disagreement with experimental measurement. Moreover, the optimum condition predicted by the kinetic equation is quite discrepant with that measured by experiment. This fact indicates the necessity of study in the measurement of rate coefficients of the continuously pumped iodine laser system.

47747 (N–89-21226) **Solar-powered alkali metal vapor lasers. Final report, 1 August 1986-31 October 1988.** Blount, C.E. Texas Christian Univ., Fort Worth, TX (USA). Feb 1989. 16p. (NASA-CR–180480;NAS–1.26:180480). Available from NTIS, PC A03/MF A01.

The emission spectrum of the A(1 Sigma u +) - X(1 Sigma g +) band of Na2 has been recorded following excitation by monochromatic radiation in the region of X-A and X-B absorption. The spectral profile has been investigated as a function of excitation wavelength, sodium vapor temperature and buffer gas pressure. Additionally, gain measurements were made for the satellite of the A-X band as a function of the sodium vapor temperature and buffer gas pressure.

47748 (UCRL–100862-Rev.1) **Ti-sapphire laser performance above 15 watts cw with line-narrowing.** Bass, I.L.; Bonanno, R.E.; Braun, D.G.; Delos-Santos, K.; Erbert, G.V.; Hackel, R.P.; Haynam, C.A.; Paisner, J.A. Lawrence Livermore National Lab., CA (USA). May 1989. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890532–1-Rev.1: Topical meeting on tunable solid state lasers, North Falmouth, MA (USA), 1-3 May 1989). Order Number DE89017541/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Over 17 W of cw output at less than 0.5 GHz linewidth was obtained from a Ti:sapphire laser pumped by 2 argon-ion lasers. Thermal instability at high pump powers was controlled by cooling the laser rod. 4 refs., 4 figs.

47749 **Double-sided coaxial laser.** Russell, S.D. To Department of the Army, Washington, DC. USA Patent 7-297,893. 17 Jan 1989. 8p. Available from NTIS, PC A02/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

The solid-metal current return in a typical commercial coaxial flashlamp is replaced with a light-transmissive current return which permits light from either or both surfaces of the flashlamp to be used to pump dye volumes. This enables one flashlamp to pump two dye volumes simultaneously, resulting in a significant increase in the overall efficiency of the co-axial flashlamp-pumped dye laser.

47750 **Static periodic field device for free-electron laser.** Ahern, B.S. To Department of the Air Force, Washington, DC. USA Patent 7-280,607. 6 Dec 1988. 13p. Available from NTIS, PC A03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

A static periodic field device for a free electron laser has a plurality of holes there through to allow the interaction of electrons flowing there through to interact with either an electric or a magnetic field as desired. The device is composed of a plurality of conducting layers separated by insulating layers and appropriately connected to provide either an electric or a magnetic field therein. The separation of the conducting layers determines the radiated energy wavelength.

4204 Heat Transfer and Fluid Flow

Refer also to citation(s) 47526, 48286

47751 (JAERI-M–89-029) **Stability of numerical solutions for stratified two-phase flow.** Watanabe, Tadashi; Hirano, Masashi. Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1989. 19p. Order Number DE90701646/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

The stability of numerical solutions for stratified two-phase flow is studied. The one-dimensional two-fluid model equations with two phasic pressures are solved by using the MINCS code. The stability analysis based on Neumann's method is carried out for the implicit upwind scheme. The stability criterion is shown in terms of the eigenvalue of amplification matrix for the discretized equation system. Through numerical examples, not only the short-wavelength instability but also the long-wavelength wave growth are shown to be well described by the stability limit determined by the eigenvalue. (author).

47752 (LA-UR–89-1584) **Design and demonstration of a high-temperature, deployable, membrane heat-pipe radiator element.** Trujillo, V.L.; Keddy, E.S.; Merrigan, M.A. Los Alamos National Lab., NM (USA). [1989]. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-890815–15: 24. intersociety energy conversion engineering conference, Arlington, VA (USA), 6-11 Aug 1989). Order Number DE89012623/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Demonstration of a high-temperature, deployable, membrane heat-pipe radiator element has been conducted. Membrane heat pipes offer the potential for compact storage, ease of transportation, self-deployment, and a high specific radiator performance (kg/kW) for use in thermal reflection systems of space nuclear power plants. A demonstration heat pipe 8-cm wide and 100-cm long was fabricated. The heat pipe containment and wick structure were made of stainless steel and sodium used as the working fluid. The tests demonstrated passive deployment of the high-temperature membrane radiator, simulating a single segment in a flat array, at a temperature of 800 K. Details of test procedures and results of the tests are presented in this paper together with a discussion of the design and development of a full-scale, segmented high-temperature, deployable membrane heat pipe. 5 refs., 7 figs.

47753 (LA-UR–89-2661) **PATRAN as an engineering design visualization tool: Design and analysis of a heat exchanger support.** Weinacht, D.J. Los Alamos National Lab., NM (USA). 1989. 16p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-8909187–1: PATRAN users conference, Costa Mesa, CA (USA), 6-8 Sep 1989). Order Number DE89016776/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The effective communication or engineering results from the finite element modeling analyst to project managers and nontechnical program sponsors often presents a significant challenge to the analyst. Also, the ability to visualize trends in finite element model results is difficult when the analyst is confronted by reams of numerical output. Recent advances in computer graphics and the proliferation of sophisticated commercially-available software have greatly enhanced the ability of the analyst to asses the results of engineering calculations and present those results to others. The use of PATRAN by an engineering mechanics group as a pre- and postprocessor for finite element modeling will be discussed. Specifically, the design and analysis of a heat exchanger support that experiences severe thermally-induced stresses will be examined. Both heat transfer and stress analyses for two different design concepts will be presented. The use of PATRAN as a visualization/presentation tool will be emphasized. The Engineering Mechanics section of the Advanced engineering Technology group provides analytical and computational support to many research and development projects at Los Alamos. Described in this paper are the thermal and structural analyses of a component for an advanced research and development project. Specifically, two design concepts for supporting a heat exchanger were examined. Models for both concepts were built using PATRAN. ABAQUS was the analysis code. The feasibility of each design was assessed based on thermal behavior and stresses and deflections in the structures. PATRAN, with its vivid portrayals of the variations of these quantities through the structures, was instrumental in these assessments. 13 figs.

47754 (N–89-21025) **Three dimensional thermal analysis of rocket thrust chambers.** Naraghi, M.H.N.; Armstrong, E.S. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Jun 1988. 33p. (NASA-TM–101973;E–4673;NAS–1.15:101973;CONF-880676–: Conference on thermophysics, plasma dynamics and lasers, San Antonio, TX (USA), 27-29 Jun 1988). Available from NTIS, PC A03/MF A01.

A numerical model for the three dimensional thermal analysis of rocket thrust chambers and nozzles has been developed. The input to the model consists of the composition of the fuel/oxidant mixture and flow rates, chamber pressure, coolant entrance temperature and pressure, dimensions of the engine, materials and the number of nodes in different parts of the engine. The model allows for temperature variation in three dimensions: axial, radial and circumferential directions and by implementing an iterative scheme, it provides nodal temperature distribution, rates of heat transfer, hot gas and coolant thermal and transport properties.

47755 (N–89-21726, pp. 20) **Role of the turbulent Prandtl number in turbine blade heat transfer prediction.** Whitaker, K.W. Alabama Univ., University, AL (USA). Dec 1988. (NASA-CR–183553;NAS–1.26:183553;CONF-8806391–: NASA/ASEE summer faculty fellowship program, Huntsville, AL (USA), 6 Jun 1988). In *Research Reports: 1988 NASA/ASEE Summer Faculty Fellowship Program.* Available from NTIS, PC A99/MF E03.

Improvement of the prediction of external (gas-to-blade) heat transfer coefficients in gas turbine engines was undertaken. The effects of improved eddy diffusivity of heat modeling in the turbulence model was specifically investigated. A two-dimensional boundary STAN5, was selected and modified by incorporating several different turbulent Prandtl number models. Results indicated that slight effects were attributable to the modified turbulence model. Boundary layer character appeared to be much more significant.

47756 Solids motion and heat transfer in gas fluidized beds. Chen, M.M. (Univ. of Illinois at Urbana-Champaign, Urbana, IL (US)). vp of Direct-contact heat transfer. Kreith, F.; Boehm, R.F. Hemisphere Publishing, New York, NY (1988).

When a bed of solid particles is subjected to an upward fluid flow above a critical velocity called the minimum fluidization velocity, the bed becomes fluid-like in a number of respects and is said to be fluidized. Because of the very large surface area, heat and mass exchange between the fluid and the solids are extremely efficient. In the case of typical gas fluidized beds, the solids also possess large mean and fluctuating velocities, thus promoting solids mixing and facilitating the addition and removal of the solids. These conditions favor the use of fluidized beds as chemical reactors, including as a special case combustors for solid, liquid, and gaseous fuels. Furthermore, the intense solids motion enhances heat exchange between the solids and immersed surfaces, permitting direct heat removal at low temperature drop using immersed heat-exchange tubes.

47757 Research needs in direct-contact heat exchange. Boehm, R.F. (Univ. of Utah, Salt Lake City, UT (US)); Kreith, F. vp of Direct-contact heat transfer. Kreith, F.; Boehm, R.F. Hemisphere Publishing, New York, NY (1988).

There are, simultaneously, marked distinctions and amazing similarity in the many facets that make up the field of direct-contact heat exchange. While on the one hand there are differences between situations where solids, liquids, and vapors are individually interacting in complex flow patterns with a surrounding fluid, these flow patterns also exhibit some of the same general characteristics. Moreover, a key ingredient of almost all of the heat transfer of processes described is a fundamental dependence on the fluid mechanics of swarms of particles in a bulk fluid. Sometimes the effects of the fluid mechanics interact with change-of-phase phenomena, but there is stsill a dependence upon the fluid motion to drive the direct-contact heat transfer process.

47758 Forced convection heat transfer of interacting spheres. Ramachandran, R.S. (North Carolina State Univ., Raleigh, NC (USA). Dept. of Mechanical and Aerospace Engineering); Kleinstreuer, C.; Wang, T.Y. *Numerical Heat Transfer (USA),* 15(4): 471-488 (1989).

A basic understanding of the highly nonlinear interaction effects of closely spaced spheres on fluid mechanics and heat transfer parameters is important for improving the design of a variety of thermal fluid-particle systems. Fluid flow patterns, isotherms, as well as Nusselt number distributions and extended correlations are presented for steady laminar axisymmetric flow past a linear array of three spheres. A finite-element method is sued to solve the complete Navier-Stokes and heat transfer equations for the system parameter ranges.

47759 Equations of state for hard-sphere fluids. Zhou, Y. (State Univ. of New York, Stony Brook (USA)); Stell, G. *International Journal of Thermophysics (USA),* 9(6): 953-963 (Nov 1988). (CONF-880606–: 10. symposium on thermophysical properties, Gaithersburg, MD (USA), 20-23 Jun 1988).

Equations of state and contact values of hard-sphere radial distribution functions (rdf's) which are given by a linear combination of the Percus-Yevick and scaled-particle virial expressions are considered. In the one-component case the mixing coefficient $\theta(\eta)$is, in general a function of the volume fraction η. In mixtures the coefficient $\theta(\eta_i, d_i)$, in general, depends upon the volume fraction η_i and diameter d_i of each species, i and j. For the contact values Y_{ij} of the rdf's, the mixing coefficients $\Theta_{ij}(\eta_k)$ also depend on species i and j. Density expansions for the exact θ for the one-component hard-sphere fluid are obtained and compared with several approximations made in earlier works and in the authors own work, as well as with simulation. For a mixture, it turns out that one cannot obtain the exact fourth virial coefficient by using a linear combination of the Percus-Yevick and scaled-particle virial expression for Y_{ij} unless one allows Θ_{ij} to depend on mole fractions x_i even at the zeroth order of its density expansion. They also find that Θ_{ij} must depend on particle species i and j in order to satisfy the exact limits obtained earlier by Sung and Stell. A new equation of state for the binary hard-sphere mixture which satisfies all the exact limits they have considered is suggested.

47760 Selected equation of state in the acentric factor system. Schreiber, D.R. (Univ. of California, Berkeley (USA)); Pitzer, K.S. *International Journal of Thermophysics (USA),* 9(6): 965-974 (Nov 1988). DOE Contract AC03-76SF00098. (CONF-880606–: 10. symposium on thermophysical properties, Gaithersburg, MD (USA), 20-23 Jun 1988).

A new equation of state in the acentric factor system is developed on the basis of high-precision data. The region in T_r, ρ_r space where there is good agreement is identified, as well as the regions of significant departures. The equation fits very well in the critical region.

4205 Materials Testing

Refer also to citation(s) 47480, 47725, 47730, 47967

47761 (ORNL/FTR–2831) **[Mechanical testing of advanced ceramics]: Foreign trip report, April 11–15, 1988.** Liu, K.C. Oak Ridge National Lab., TN (USA). 2 May 1988. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017286/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler attended the conference, "Mechanical Testing of Engineering Ceramics at High Temperatures," and presented two invited papers. The primary purpose of this conference was to review the development of test equipment and methods, with special emphasis on uniaxial stressing and strain extensometry, and to establish future requirements for international standards. The traveler also visited the National Physical Laboratory, the ceramic laboratory of Rolls Royce, that of the Netherlands Energy Research Foundation, and held discussions and exchange of information involving test methods and equipment for performing tensile strength and tensile creep testing of ceramic materials at high temperatures. 20 figs.

4208 Electronic Circuits and Devices

Refer also to citation(s) 47244, 47282

47762 (AD-A–207430/0/XAB) **Wigner-function modeling of resonant tunneling diodes with high peak-to-valley ratios.** Mains, R.K.; Haddad, G.I. Michigan Univ., Ann Arbor, MI (USA). Center for High Frequency Microelectronics. 15 Nov 1988. 5p. Available from NTIS, PC A02/MF A01.

Pub. in Jnl. of Applied Physics, Vol. 64, No. 10, 5041-5044(15 Nov 1988).

Wigner-function simulations of structures with experimentally observed high peak-to-valley ratios are carried out. It is shown that if care is taken with the numerical method used, the simulations reproduce these sharp resonances. When scattering is ignored, peak-to-valley ratios of 33.7 are obtained for a pseudomorphic InGaAs-AlAs structure. The effects of phonon scattering are included to first order. Also, a small signal analysis is carried out and the results are used to predict the rf power generation capability of these devices.

47763 (AD-A–207589/3/XAB) **Comparison of superconductive and surface-acoustic-wave signal processing.** Withers, R.S. Massachusetts Inst. of Tech., Lexington, MA (USA). Lincoln Lab. 1988. 12p. (MS–8017). Available from NTIS, PC A03/MF A01.

Pub. in Ultrasonics Symposium, 185-194(1988).

The advent of superconductors with transition temperatures exceeding 77 K has focused a great deal of attention on, among other things, superconductive electronics. Even before the recent breakthroughs, a few small research teams around the world were developing digital and analog circuits utilizing the niobium and lead-based superconductors. A number of analog signal-processing devices with functions analogous to those of more mature surface-acoustic-wave (saw) devices have been demonstrated, including filters, resonators, pulse compressors, convolvers, and correlators. Most of these devices exploit the extremely low microwave surface resistance of superconducting thin films to obtain highly compact yet low-loss electromagnetic delay lines, and some incorporate tunnel junctions for nonlinear functions. In this paper, the design and fabrication of the superconductive devices are discussed, and they are compared to SAW devices in terms of bandwidth, delay, transduction loss, and interface requirements. Two examples with particularly strong analogy to SAW devices are presented: (1) chirp filters for pulse compression and spectral analysis; and (2) high-Q resonators for use in low-phase-noise oscillators. The prospects for devices operating in liquid nitrogen are explored.

47764 (EPRI-GS–6475-Vol.1) **Self-calibrating power angle instrument: Volume 1, A functional overview: Final report.** Demcko, J.A.; Chrysty, J.P. Electric Power Research Inst., Palo Alto, CA (USA); Arizona Public Service Co., Phoenix, AZ (USA). c Aug 1989. 110p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This report provides functional documentation of the development of a second generation electronic power angle instrument (PAI) for synchronous machines. The first generation device, also developed by EPRI funded research, proved the viability of the measurement concept but required human intervention for recalibration each time an input quantity was removed or the instrument power supply was lost. Loss of input intelligence also occurs each time a synchronous motor or generator is removed from service, thereby forcing additional recalibrations. The self-calibrating PAI automatically recalibrates itself for any contingency and as its predecessor, provides accurate low cost steady state and transient power angle measurements for both synchronous motors and generators. The report covering EPRI sponsored research project RP2591-1 includes a detailed PAI functional block diagram description as well as autocal PAI performance specification as measured in the lab. Several ancillary equipments were developed in support of the autocal project. These include an infrared optoprobe which replaces toothed wheel PAI input, an optoelectronic probe and tooth wheel test bed, and an electronic turbine generator simulator for PAI functional test and calibration. 24 figs.

47765 (EPRI-GS–6475-Vol.2) **Self-calibrating power angle instrument: Volume 2, Theory, operation, and maintenance: Final report.** Demcko, J.A.; Chrysty, J.P. Electric Power Research Inst., Palo Alto, CA (USA); Arizona Public Service Co., Phoenix, AZ (USA). c Aug 1989. 229p. Sponsored by Electric Power Research Institute. Available from Research Reports Center, Box 50490, Palo Alto, CA 94303.

This document provides all the necessary information to construct, calibrate, operate and maintain the self-calibrating power angle instrument (PAI). The PAI was developed far past the laboratory prototype stage to a commercially viable device. It is manufactured by EUMAC, Inc., Phoenix, AZ under EPRI license or may be constructed by an EPRI member utility from documentation in the report appendices. The self-calibrating PAI must be functionally checked and calibrated. An electronic generator simulator was developed specifically for this purpose. Besides greatly simplifying test and calibration, the simulator is estimated to cost less than 5% of the large assembly of special instruments required otherwise. Comprehensive simulator documentation is provided herein as well. The PAI fills a void in power system measurement techniques in that synchronous motor or generator power angle, typically denoted by the symbol δ, may now be continuously and accurately monitored at reasonable cost. Power angle data may be used to assess synchronous machine stability in real time, improve synchronous machine mathematical models, monitor the impact of highly underexcited operation upon stability and in generator anti-motoring protection. The self-calibrating PAI described herein is capable of operating for a period of years without attention from plant personnel. 25 figs.

47766 (LA-UR–89-2921) **Exploding metallic foil fuse modeling at Los Alamos.** Lindemuth, I.R.; Reinovsky, R.E.; Goforth, J.H. Los Alamos National Lab., NM (USA). [1989]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-890710–17: 5. international conference on megagauss magnetic field generation and related topics, Novosibirsk (USSR), 3-7 Jul 1989). Order Number DE89016970/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A "first-principles" computational model of exploding metallic foil behavior has been developed at Los Alamos. The model couples zero-dimensional magnetohydrodynamics with ohmic heating and electrical circuit equations and uses the Los Alamos SESAME atomic data base computer library to determine the foil material's temperature- and density-dependent pressure, specific energy, and electrical conductivity. The model encompasses many previously successful empirical models and offers plausible physical explanations of phenomena not treated by the empirical models. In addition to addressing the electrical circuit performance of an exploding foil, the model provides information on the temporal evolution of the foil material's density, temperature, pressure, electrical conductivity, and expansion and translational velocities. In this paper, we report the physical insight gained by computational studies of two opening switch concepts being developed for application in an FCG-driven 1-MJ-class imploding plasma z-pinch experiment. The first concept considered is a "conventional" electrically exploded fuse, which has

been demonstrated to operate at 16 MA driven by the 15-MJ-class FCG to be used in the 1 MJ implosion experiment. The second concept considered is a Type 2 explosively formed fuse (EFF), which has been demonstrated to operate at the 8 MA level by a 1-MJ-class FCG.

47767 (SAND–89-1954C) **An empirical formula for gas switch breakdown delay.** Martin, T.H. Sandia National Labs., Albuquerque, NM (USA). [1989]. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-890665–45: 7. Institute of Electrical and Electronics Engineers pulsed power conference, Monterey, CA (USA), 12-14 Jun 1989). Order Number DE89017233/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An empirical scaling relationship between the mean electric field and the breakdown time has been found. Many divergent sets of data were used from breakdown experiments on power lines, laser-triggered switches, trigatrons, e-beam triggered gaps, sharp-point electrode to plane gaps, and uniform field gaps. This relationship builds on the Felsenthal and Proud data and extends their breakdown time delay (formative time) data by three orders of magnitude and into the region of interest for triggered gas switching. The data indicates that electrically triggered gaps, laser-triggered gaps, and untriggered gaps are governed by the same time-delay processes. Predictions can be made of trigger gap geometry, trigger delays, and trigger polarity effects. Breakdown delays of sub-centimeter-long to at least 8-meter-long gaps in air with either high or low field-enhanced electrodes are described by this equation. In addition, this relationship appears to be valid for a variety of gases and even accurately predicts the breakdown delay of mixtures of air and SF_6. 13 refs., 12 figs., 1 tab.

47768 (UCRL–100642) **High gain flux compression generator fabrication issues.** Cutting, J.L.; Abe, D.K.; Chase, J.B.; Hawke, R.S.; Pincosy, P.A.; Takemori, H.T.; Fillipucci, M.L. Lawrence Livermore National Lab., CA (USA). 21 Jul 1989. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890710–18: 5. international conference on megagauss magnetic field generation and related topics, Novosibirsk (USSR), 3-7 Jul 1989). Order Number DE89017888/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper discusses the fabrication issues involved with a high gain helical flux compression generator. The generator is 20 cm in diameter, 76 cm long, contains 4500 gm of explosives, and its desired output is 2 million amperes into a 200-nH load. Our goal is to attain better than 1000 X current multiplication. To achieve this goal great attention must be made to details such as mechanical fabrication tolerances, repeatability, and assembly techniques. 4 refs., 5 figs.

47769 (UCRL–101192) **Performance of transient limiters under laboratory, simulated, and rocket-triggered lightning conditions.** Hasbrouck, R.T.; Johnson, J.P.; Breitmeier, J. Lawrence Livermore National Lab., CA (USA). 2 Jul 1989. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8909124–4: International conference on lightning and static electricity, Bath (UK), 26-28 Sep 1989). Order Number DE89015773/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We have designed and tested a prototype system that implements a lightning-protection method referred to as the "fortress concept." The fortress, a structure similar to a Faraday cage, protects the critical system by surrounding it with a continuous metallic skin. Each electrical conductor that must enter the fortress is enclosed within a cable, which is, in turn, enclosed in a metallic shield that terminates at the entry point and is electrically bonded to the fortress' outer metallic surface. Within the fortress, each penetrating conductor is protected by a transient limiter. The system was tested by means of full-threat-level simulated lightning and actual lightening triggered by rockets. Several limited components were subsequently tested by using a laboratory-type surge generator to investigate certain anomalous responses. This paper reviews the fortress concept, discusses the operation of the limiters, and examines their performance. Explanations are offered for the anomalous responses, and several important design considerations and tradeoffs are offered. 3 refs., 15 figs.

47770 Concurrent algorithms for a mobile robot vision system. Jones, J.P. (Engineering Physics and Mathematics Div., Oak Ridge National Lab., Oak Ridge, TN (US)); Mann, R.C. vp of Applications of artificial intelligence VI. Trivedi, M.M. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (1988). (CONF-880464–: Applications of artificial intelligence VI, Orlando, FL (USA), 4-6 Apr 1988).

The application of computer vision to mobile robots has generally been hampered by insufficient on-board computer power. The advent of VLSI-based general purpose concurrent multiprocessor systems promises to give mobile robots an increasing amount of onbosrd computing capability, and to allow computation intensive data analysis to be performed without high-bandwidth communication with a remote system. This paper describes the integration of robot vision algorithms on a 3-dimensional hypercube system on-board a mobile robot developed at Oak Ridge National Laboratory. The vision system is interfaced to navigation and robot control software, enabling the robot to maneuver in a laboratory environment, to find a known object of interest and to recognize the object's status based on visual sensing. The authors first present the robot system architecture and the principles followed on the vision system implementation. They then provide some benchmark timings for low-level image processing routines, describe a concurrent algorithm with load balancing for the Hough transform, a new algorithm for binary component labeling, and an algorithm for the concurrent extraction of region features from labeled images. This system analyzes a scene in less than 5 seconds and has proven to be a valuable experimental tool for research in mobile autonomous robots.

47771 An expert system for automating security incident assessment using OPS5 in an Ada environment. Canales, T.W. (Lawrence Livermore National Lab., Electronics Engineering Dept., P.O. Box 808, Livermore, CA (US)); Smart, J.C. vp of Applications of artificial intelligence VI. Trivedi, M.M. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (1988). (CONF-880464–: Applications of artificial intelligence VI, Orlando, FL (USA), 4-6 Apr 1988).

An expert system that automatically assesses security is being developed at Lawrence Livemore National Laboratory. The expert system associates, classifies, and prioritizes monitored sensor events. The outcome of these processes is a dynamic representation of the state of Laboratory security in the form of security incidents. A graphical representation of the incidents is integrated into a map-oriented console monitor that provides the operator with a comprehensive view of incidents and their locations. A prototype expert system has been developed using the OPS5 rulebased language. A large Ada-based program provides control of the map display system and interfaces to the various monitoring and access-control devices. In addition to the expert system operation, the issues and methods involved in integrating the OPS5-based incident-assessment system to the large Ada-based control program are discussed.

47772 Gyroklystron device having multi-slot bunching cavities. Gold, S.H.; Fliflet, A.W. To Department of the Navy, Washington, DC. USA Patent 7-304,442. 31 Jan 1989. 22p. Available from NTIS, PC A03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

A gyroklystron device includes an electron beam source, a plurality of bunching cavities, and an output cavity. A first bunching cavity has an input coupling aperture for receiving an rf signal from an rf signal injecting source. Each of the bunching cavities has a first pair of substantially uniform-angle slots of a preselected angle, which are diametrically opposed, and extend axially, parallel to the direction of the electron beam and extend into drift regions on both sides of the cavities. The first pair of slots control the Q of a desired mode and higher-order modes. A second and third pair of slots are diametrically opposed and extend axially, parallel to the direction of the first pair of slots, but are rotated 90° circumferentially from the first pair of slots. These slots control the axial profile of any mode that leaks out beyond the desired mode and control the length of field interaction with the electron beam. The second and third pair of slots begin in the walls of drift regions just beyond the first pair of slots, and have a preselected angle at their beginning and the angle

increases in size along an axial distance away from the cavities. An outer vacuum jacket lined with rf-absorbing material is also included such that rf energy leaving through the slots will not return.

4209 Waste Processing Plants and Equipment

Refer also to citation(s) 47027

4210 Combustion Systems

Refer also to citation(s) 47403, 47754, 47755

47773 A model gas turbine combustor with wall jets and optical access for turbulent mixing, fuel effects, and spray studies. Cameron, C.D. (Univ. of California, Irvine (USA)); Brouwer, J.; Samuelsen, G.S. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

A model laboratory reactor is presented and characterized for the study of spray-fired combustion in a swirl-stabilized, complex, three-dimensional flow representative of a gas turbine combustor. The reactor features optical access for non-intrusive diagnostics, and clean boundary conditions for modeling. The aerodynamic and thermal fields are characterized using laser anemometry and a thermocouple probe respectively. The droplet size and droplet velocity fields are resolved using phase Doppler interferometry. The performance of the reactor is found to be representative of a practical combustor with a well defined dome region primary zone, a secondary zone between the two rows of wall jets in which reaction persists, and a relatively well-mixed and cool dilution zone. A parametric study of the dome geometry indicates that the structure of the dome region recirculation is relatively insensitive to a change from a step to a 45° divergent dome expansion. A parametric study of the dome swirl, primary jet, and dilution jet flows shows that the primary air provides closure to the dome recirculation and enhances the turbulent mixing. The reactor is attractive for studies of turbulent mixing, fuel effects, and spray dynamics in this class of flows.

47774 (N–89-20135) **Toward improved durability in advanced aircraft engine hot sections.** Sokolowski, D.E. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Apr 1989. 121p. (NASA-TM–4087;E–4468;NAS–1.15:4087;CONF-880607–: 33. ASME international gas turbine and aeroengine congress and exposition, Amsterdam (Netherlands), 5-8 Jun 1988). Available from NTIS, PC A06/MF A01.

The conference on durability improvement methods for advanced aircraft gas turbine hot-section components discussed NASA's Hot Section Technology (HOST) project, advanced high-temperature instrumentation for hot-section research, the development and application of combustor aerothermal models, and the evaluation of a data base and numerical model for turbine heat transfer. Also discussed are structural analysis methods for gas turbine hot section components, fatigue life-prediction modeling for turbine hot section materials, and the service life modeling of thermal barrier coatings for aircraft gas turbine engines.

47775 (N–89-20135, pp. 83-95) **Structural analysis applications.** Mcknight, R.L. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Apr 1989. (NASA-TM–4087;E–4468;NAS–1.15:4087;CONF-880607–: 33. ASME international gas turbine and aeroengine congress and exposition, Amsterdam (Netherlands), 5-8 Jun 1988). In *Toward improved durability in advanced aircraft engine hot sections.* Available from NTIS, PC A06/MF A01.

An account is given of the application of computer codes for the efficient conduct of three-dimensional inelastic analyses to aircraft gas turbine combustor, turbine blade, and turbine stator vane components. The synergetic consequences of the program's activities are illustrated by an evaluation of the computer analyses of thermal barrier coatings and of the Space Shuttle Main Engine's High Pressure Fuel Turbopump turbine blading. This software, in conjunction with state-of-the-art supercomputers, can significantly reduce design-task burdens.

47776 (N–89-20472) **High speed balancing applied to the T700 engine. Final report.** Walton, J.; Lee, C.; Martin, M. Mechanical Technology, Inc., Latham, NY (USA). Mar 1989. 110p. (NASA-CR–180899;NAS–1.26:180899;MTI–87TR56;AVSCOM-TR–88-C-007). Available from NTIS, PC A06/MF A01.

The work performed under Contracts NAS3-23929 and NAS3-24633 is presented. MTI evaluated the feasibility of high-speed balancing for both the T700 power turbine rotor and the compressor rotor. Modifications were designed for the existing Corpus Christi Army Depot (CCAD) T53/T55 high-speed balancing system for balancing T700 power turbine rotors. Tests conducted under these contracts included a high-speed balancing evaluation for T700 power turbines in the Army/NASA drivetrain facility at MTI. The high-speed balancing tests demonstrated the reduction of vibration amplitudes at operating speed for both low-speed balanced and non-low-speed balanced T700 power turbines. In addition, vibration data from acceptance tests of T53, T55, and T700 engines were analyzed and a vibration diagnostic procedure developed.

47777 (TTKK-LT–49) **Modelling of confined swirling flows.** Ahlstedt, H. Tampere Univ. of Tech. (Finland). Thermal Engineering. 1987. 52p. Order Number DE89914702/JAW. Available from NTIS (US Sales Only), PC A04/MF A01.

This work deals with the modelling of swirling flows in combustion chambers and cyclones. The effect of the k-e turbulence model with different kinds of corrections and the effect of the algebraic stress model on the results calculated is shown and compared with experimental data. A combustion chamber with moderate swirling numbers can be calculated using the standard k-e model when care is taken to prevent numerical diffusion that can distort results. In cyclone combustors and cyclones the k-e model fails. In these cases the algebraic stress model with added convection terms gives results which are in reasonable agreement with measurements.

47778 (VTT-TUTK–619) **Real time measurement of combustion aerosol size distributions.** Kauppinen, E.; Heiskanen, M.; Hahkala, M. Valtion Teknillinen Tutkimuskeskus, Espoo (Finland). May 1989. 40p. (In Finnish). Order Number DE89914692/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

A real time method to measure combustion aerosol size distributions with high particle size resolution has been developed. Flue gas is first diluted and cooled with the dilution system, followed by the differential mobility particle size analyzer (DMPS) and the aerodynamic particle sizer (APS) used to measure aerosol number size distributions in the size ranges 0.01-1 μm, respectively. The dilution system includes two dilution units, which have the dilution ratio in the range 4.3-71. The total dilution ratio can be adjusted within the range 19-5041. The dilution units were calibrated in laboratory conditions. When the sample and the dilution ai flow rates were 1.0-2.7 l/min and 10-70 l/min, respectively, and the particle diameter 0.014-0.191 μm, calculated and measured dilution ratios agreed within the accuracy of the measured results. The size distributions of the oil combustion aerosols were measured with the developed method. Light fuel oil was burned in 19 kW boiler using two different burners. The number size distributions were unimodal with most of the particles in the size range 0.02-0.2 μm. The mass distributions were clearly bimodal, having a fine mode at about 0.2 μm and a coarse mode above 10 μm. Fine particle concentrations and mean particle diameter increased with increased furnace efficiency and flue gas CO concentration, i.e., when decreasing the air/fuel ratio. They also increased when the air/fuel ratio was very large. The shape of the size distribution measured for buners 1 and 2 under similar conditions was similar, but boiler 1 produced flue gases with higher particle concentrations. The differences in the size distributions measured for the burner 2 when burning summe and winter grades of light fuel oil, respectively, were found to be negligible.

4220 Underground Engineering

47779 (CONF-881054–Vol.5, pp. 1585-1595) **Management program for underground storage tanks at the Idaho National Engineering Laboratory.** Broomfield, B.J. (EG and G Idaho, Inc., Idaho Falls (USA)). Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988.

DOE Contract AC07-76ID01570. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 5.* Order Number DE89014704/JAW. Available from NTIS, PC A13/MF A01.

In anticipation of national Underground Storage Tank (UST) regulations, the Idaho National Engineering Laboratory (INEL) developed a comprehensive management program for USTs. The purpose of the INEL UST management program is to ensure progress toward the compliance of regulations while minimizing costs and impacts to on-site operations involving tanks. The program considers UST standards for new tank design, construction, installation, operation, maintenance, replacement, and record keeping. It focuses on obtaining pertinent data and developing a method to assess the probability of tank failure, determine risks from tank releases, and prioritizing tanks for upgrading to new performance standards or replacement.

4250 Power Cycles

Refer also to citation(s) 46879, 47712, 47715

43 PARTICLE ACCELERATORS

Refer also to citation(s) 48245

4301 Design, Development, and Operation

Refer also to citation(s) 47439, 48322

47780 (BNL–42946) **Considerations in SR facility planning: Technical options in the design of an intermediate energy synchrotron radiation source.** van Steenbergen, A. Brookhaven National Lab., Upton, NY (USA). 1989. 26p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-8905210–2: International conference on synchrotron radiation application, Hefei (China), 9-12 May 1989). Order Number DE89017831/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The parameter optimization and design options of a state of the art intermediate energy synchrotron radiation source are considered. This includes consideration of beam energy, current and emittance; ring magnet lattice, the use of insertion devices and related parameters and various technological aspects. 21 refs., 10 figs., 8 tabs.

47781 (BNL–43105) **The national synchrotron light source and its applications.** Williams, G.P. Brookhaven National Lab., Upton, NY (USA). 1989. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-8905210–1: International conference on synchrotron radiation application, Hefei (China), 9-12 May 1989). Order Number DE89017605/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We describe the National Synchrotron Light Source facility including its beamlines and operational characteristics. Research results on selected beamlines on the VUV ring which highlight new experimental capabilities are described since they are more relevant to the program at HESYRL. Examples chosen are spin-polarized photoemission, infra-red surface science, high resolution core level spectroscopy, X- Ray lithography, photoelectron/Auger coincidence spectroscopy and high electron momentum resolution surface studies. 7 refs., 3 figs., 3 tabs.

47782 (BNL–52195) **Conceptual design of the Relativistic Heavy Ion Collider [RHIC].** Brookhaven National Lab., Upton, NY (USA). May 1989. 283p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. Order Number DE90000524/JAW. Available from NTIS, PC A13/MF A01; OSTI; INIS; GPO Dep.

In August 1984 Brookhaven National Laboratory submitted a proposal for the construction of a Relativistic Heavy Ion Collider (RHIC) to the US Department of Energy. A Conceptual Design Report for the RHIC facility was completed in May 1986 after detailed reviews of the machine design, and of the requirements of the physics research program. Since that time an extensive R&D program has been initiated and considerable work has been carried out to refine the design and specification of the major accelerator components, as well as the needs for research detectors, and to prepare the project for construction. This document is an update of the Conceptual Design Report, incorporating the results of work carried out since the beginning of Fiscal Year 1987 when a formal R&D program for the RHIC project funded by DOE was initiated.

47783 (FNAL/C–89/182) **Tevatron collider: Status and prospects.** Dugan, G. Fermi National Accelerator Lab., Batavia, IL (USA). Aug 1989. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-890803–12: International conference on high energy accelerators, Tsukuba (Japan), 20-26 Aug 1989). Order Number DE89017651/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

During the 1988–1989 run, the Fermilab Tevatron proton-antiproton collider exceeded the design luminosity goal of $10^{30}/cm^2/sec$ and delivered 9.6 pb^{-1} of integrated luminosity at 1800 GeV to the CDF experiment. Based on the operational experience accumulated during this collider run, the performance of the Tevatron collider will be reviewed. This review will treat not only the Tevatron itself, but also the auxiliary accelerator systems necessary for collider operation. The performance and the limitations in each of the accelerator subsystems will be discussed and analyzed. The plans to overcome some of these limitations in the next collider run will also be discussed. Finally, the status of longer-term upgrade proposals for the early 1990's focused on increased luminosity will be presented. 10 refs., 2 figs., 2 tabs.

47784 (FNAL-TM–1574) **Report of the Ad Hoc Committee on Test Beam Policy.** Stefanski, R.; Anderson, D.; Childress, S.; Coleman, R.; Fisk, H.E.; Garbincius, P.; Holmes, S.; Kephart, R.; Kreisler, M.; Lubatti, H.; Siegrist, J. Fermi National Accelerator Lab., Batavia, IL (USA). 20 Mar 1989. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. Order Number DE89016706/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This document was developed at the request of the Physics Advisory Committee of the Fermi National Accelerator Laboratory to review the general subject of test beams with the purpose of establishing general policy and guidelines for consideration of future test beam requests. The recommendations stated here should be subject to periodic review, since the Laboratory position must change as needs and available resources change.

47785 (FNAL-TM–1593) **Experimental area power monitoring during shutdown.** Pathiyil, J. Fermi National Accelerator Lab., Batavia, IL (USA). Mar 1989. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. Order Number DE89016707/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The power consumption at the site is increasing every year and the power consumption in the fixed target beam lines is constantly changing for each run. Since we do not have an energy monitoring program in effect in the experimental areas; we are not in a position to tell whether we are using the electrical energy efficiently. The purpose of this study is to find the summer and winter base load of the three experimental areas while the beamlines are off and also to identify what kind loads are on. The most important purpose was to find the base loads in each of the big experimental halls during the shutdown.

47786 (LA-UR–89-2894) **A proposed linac cavity rf drive system for the Los Alamos extreme ultraviolet free-electron laser.** Johnson, W.J.D. Los Alamos National Lab., NM (USA). [1989]. 10p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-8908134–1: 11. international free electron laser conference, Naples, FL (USA), 28 Aug - 1 sep 1989). Order Number DE89016614/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Since 1979, scientists and engineers at the Los Alamos National Laboratory have designed, constructed, and operated a radio-frequency (RF) linac free-electron laser (FEL) at wavelengths from 9 to 45 μm. Coupled with success of other research centers investigating wavelengths from the visible to far-infrared, Los Alamos is now proposing a vacuum-ultraviolet and soft x-ray [referred to henceforth as extreme ultraviolet, (XUV)] FEL oscillator/Self-Amplified Spontaneous Emission amplifier with beam energies

ranging from 100 MeV to 1 GeV. This paper will focus on the first milestone of the proposed Los Alamos XUV project, i.e., a 250-MeV linac with approximately 50 mA of average current, producing photons with wavelengths below 1000 Å. 3 refs., 3 figs.

47787 (ORNL/FTR–3122) **[Sulfur 32 beams on the CERN SPS synchrotron]: Foreign trip report, November 1–2, 1988.** Young, G.R. Oak Ridge National Lab., TN (USA). 21 Nov 1988. 3p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017374/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The purpose of this travel was to discuss further beam time on the CERN SPS accelerator with representatives of the SPS Program Committee and Scientific Directorate. Discussions with members of the CERN LEAR Experiment PS-202 were also held concerning electromagnetic calorimeters built with scintillating fibers as active elements.

47788 (ORNL/FTR–3174) **[Lead beams at CERN SPS synchrotron]: Foreign trip report, January 30, 1989–February 3, 1989.** Young, G.R. Oak Ridge National Lab., TN (USA). 14 Feb 1989. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017378/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler participated in a WA80 collaboration meeting aimed at discussing physics results of the past six months and at preparing for the long 1990 run with heavy ions, presently envisaged by CERN. A major decision concerning the nature of the new hardware used for photon detection must be made soon. Strong arguments were presented at this collaboration meeting of the need for excellent intrinsic resolution. Some discussions about possible lead-beam experiments at CERN in the 1993 time frame also occurred.

47789 **Future high energy heavy ion physics at Brookhaven.** Samios, N.P. (Brookhaven National Lab., Upton, NY (USA)); Ludlam, T.W. *Nuclear Physics [Section] A (Netherlands)*, 498: 498 (10 Jul 1989). (CONF-8809203–: Quark Matter '88: 7th international conference on ultrarelativistic nucleus-nucleus collisions, Lenox, MA (USA), 26-30 Sep 1988).

At present the AGS at Brookhaven is capable of accelerating ions up to silicon with an energy of 14.5 GeV/amu, using one of the two BNL Tandem Van de Graaff accelerators as injector. Very soon, using the AGS Booster synchrotron which is presently under construction, the range of ion masses which will be available from the AGS will be extended up to Gold. The Tandem-Booster-AGS complex will then not only be available to provide beams for fixed-target heavy ion experiments, but will serve as injector for the RHIC collider. (orig./HSI).

4302 Beam Dynamics, Field Calculations, and Ion Optics

Refer also to citation(s) 47734, 48291

47790 (BNL–42990) **Heavy ion acceleration at the AGS: Present and future plans.** Lee, Y.Y. Brookhaven National Lab., Upton, NY (USA). 1989. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-8907144–1: Summer symposium on synchrotron orbital radiation and heavy ion accelerator science, Seoul (Republic of Korea), 4-6 Jul 1989). Order Number DE90000026/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Brookhaven AGS is alternating gradient synchrotron, 807 meters in circumference, which was originally designed for only protons. Using the 15 MV Brookhaven Tandem Van de Graaff as an injector, the AGS started to accelerate heavy ions of mass lighter than sulfur. Because of the relatively poor vacuum ($\sim 10^{-8}$ Torr), the AGS is not able to accelerate heavier ions which could not be fully stripped of electrons at the Tandem energy. When the AGS Booster, which is under construction, is completed the operation will be extended to all species of heavy ions including gold and uranium. Because ultra-high vacuum ($\sim 10^{-11}$ Torr) is planned, the Booster can accelerate partially stripped elements. The operational experience, the parameters, and scheme of heavy ion acceleration will be presented in detail from injection to extraction, as well as future injection into the new Relativistic Heavy Ion Collider (RHIC). A future plan to improve intensity of the accelerator will also be presented. 5 figs., 4 tabs.

47791 (BNL–43175) **Impedances and instabilities of the AGS Booster.** Ruggiero, A.G. Brookhaven National Lab., Upton, NY (USA). [1989]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-890803–13: International conference on high energy accelerators, Tsukuba (Japan), 20-26 Aug 1989). Order Number DE89017827/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

In this paper we review calculations done recently to demonstrate the stability of beam bunches in the AGS Booster for both cases of protons and heavy ions. 1 ref., 2 figs., 2 tabs.

47792 (BNL–43204) **Microwave instability near transition energy.** Wei, J.; Lee, S.Y. Brookhaven National Lab., Upton, NY (USA). 1989. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-890803–16: International conference on high energy accelerators, Tsukuba (Japan), 20-26 Aug 1989). Order Number DE90000107/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Monte Carlo simulation for the microwave instability agrees with analytic calculation solving the Vlasov equation, provided that bunch shape distortion due to coupling is taken into account. 9 refs., 2 figs.

47793 (FNAL-TM–1603) **Exploratory orbit analysis of Tevatron helical upgrade: One: A first look.** Michelotti, L.; Saritepe, S. Fermi National Accelerator Lab., Batavia, IL (USA). Apr 1989. 49p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. Order Number DE89016711/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A key feature of the Tevatron upgrade is the placement of proton and anti-proton bunches on the branches of a double helix which winds around the current closed orbit. Electrostatic separators will transfer the bunches on and off the double helix so that they experience head-on collisions only at the experimental areas, B0 and D0, all other encounters occurring at large transverse separation. In this way the number of bunches, and the luminosity, can be increased without a proportional growth in the beam-beam tune shift. The scenario raises a number of beam dynamics issues, especially (a) the consequences of sampling magnetic fields far from the magnets' center lines, and (b) the effects of the long-range beam-beam interaction. This report presents the results of calculations and simulations done to date to explore (b); a Fermilab team have been studying (a), both experimentally and theoretically, but we shall not review those efforts here. 9 refs., 17 figs.

47794 (FNAL-TM–1607) **Calculation of integrated luminosity for beams stored in the Tevatron collider.** Finley, D.A. Fermi National Accelerator Lab., Batavia, IL (USA). 20 Mar 1989. 3p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. Order Number DE89016709/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS.

A model for calculating the integrated luminosity of beams stored in the Tevatron collider will be presented. The model determines the instantaneous luminosity by calculating the overlap integral of bunched beams passing through the interaction region. The calculation accounts for the variation in beam size due to the beta functions and also for effects due to finite longitudinal emittance and non-zero dispersion in the interaction region. The integrated luminosity is calculated for the beams as they evolve due to processes including collisions and intrabeam scattering. The model has been applied to both the extant and upgraded Tevatron collider, but is not limited to them. The original motivation for developing the computer model was to determine the reduction in luminosity due to beams with non-zero longitudinal emittances. There are two effects: the transverse beam size is increased where the dispersion is non-zero; the finite length of the beam bunch combined with an increasing β function results in an increased transverse beam size at the ends of the bunch. The derivation of a sufficiently useful analytic expression for the luminosity proved to be intractable. Instead, a numerical integration computer program was developed to calculate the luminosity in the presence of a finite longitudinal emittance. The program was then expanded into a model which allows the luminosity to vary due to changes in emittances and reduction in bunch intensities. At that

point, it was not difficult to calculate the integrated luminosity. 5 refs., 2 figs., 4 tabs.

47795 (LA–11228-MS) **Beam profile effects on NPB performance.** Leclaire, R.J. Jr.; Bunker, W.J. Los Alamos National Lab., NM (USA). Mar 1988. 19p. Available from NTIS, PC A03/MF A01.

A comparison of neutral particle beam (NPB) brightness for various neutral beam profiles indicates that the widely used assumption of a Gaussian profile may be misleading for collisional neutralizers. An analysis of available experimental evidence shows that lower peaks and higher tails, compared to a Gaussian beam profile, are observed out of collisional neutralizers, which implies that peak brightness is over estimated, and for a given NPB platform-to-target range, the beam current (power), dwell time or some combination of such engagement parameters would have to be altered to maintain a fixed dose on the target. Based on the present analysis, this factor is nominally about 2.4 but may actually be as low as 1.8 or as high as 8. This is an important consideration in estimating NPB constellation performance in SDI engagement contexts.

47796 (ORNL/FTR–2464) **[The first WA80 production run with ^{16}O nuclei at ultrarelativistic energies]: Foreign trip report, November 4, 1986–December 11, 1986.** Awes, T.C.; Plasil, F.; Young, G.R. Oak Ridge National Lab., TN (USA). 8 Jan 1987. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017414/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Final preparations were made for the WA80 production run with ultrarelativistic ^{16}O nuclei. The evaluation of calibration data obtained earlier was completed, and decisions were made regarding the appropriate gain settings of the Wall Calorimeter for ^{16}O beams. The production run took place from November 19 to December 8. The energy of the oxygen projectiles was 3.2 TeV from November 19 to December 3 and 960 GeV during the remainder of the run. Except for occasional minor problems, all detector systems, as well as the CERN accelerator complex, performed very well. The run was an unqualified success.

47797 (ORNL/FTR–2860) **[Lead beams at CERN]: Foreign trip report, April 14, 1988–April 29, 1988.** Plasil, F. Oak Ridge National Lab., TN (USA). 5 May 1988. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017415/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler attended a WA80 collaboration meeting at which results of recent data analysis were discussed. Plans for an extension request covering 1989–90 were considered. Possible experimental configurations suitable for measurements with lead beams were discussed. The traveler participated in a number of discussions with members of other collaborations regarding the possibility of joint efforts for lead-beam experiments. The traveler attended a formal meeting on future lead beams at CERN at which several interesting experimental scenarios were presented.

47798 (SAND–89-0571) **BUCKSHOT simulations of electron beam transport in rectangular IFR [Ion Focused Regime] channels using ATA parameters.** Wagner, J.S.; Godfrey, B.B. Sandia National Labs., Albuquerque, NM (USA). May 1989. 35p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. Order Number DE89016670/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Recent experiments on Lawrence Livermore's ATA indicate that there may be problems with the IFR (Ion Focused Regime) transport of the relativistic electron beam (REB) through the ATA accelerator. For beam currents greater than about 7-kA, the beam is observed to be inverse-tailored with the beam radius increasing from beam head to tail. This inverse-tailoring is considered unfavorable for endo- atmospheric beam propagation. An unusual feature of ATA's laser-produced IFR channel is that it has a rectangular cross-section. One possible explanation for the lack of good beam transport may be ion motion in the IFR channel which disrupts the tail of the beam. In this report an ATA-like electron beam, propagating on a laser-ionized rectangular IFR channel is simulated using the 3-D magnetostatic code BUCKSHOT. The simulations demonstrate that non-axisymmetric ion motion, similar to the ion hose instability, can produce an inverse- tailored electron beam similar to those found in the experiment. The simulation results should be relevant to upcoming TROLL experiments with a laser-ionized IFR channel, with several beam parameters similar to ATA's. 1 ref., 22 figs.

4303 Auxiliaries and Components

Refer also to citation(s) 47732, 47733, 47786, 48691

47799 (BNL–41891) **The Brookhaven accelerator test facility injection system.** Wang, X.J.; Kirk, H.G.; Pellegrini, C.; McDonald, K.T.; Russell, D.P. Brookhaven National Lab., Upton, NY (USA). 1989. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-890335–253: 13. particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989). Order Number DE89017599/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The Brookhaven Accelerator Test Facility (ATF) consists of a 50-MeV/c electron linac and a high-brightness RF-gun both operating at 2856 MHz. An extremely short (a few picoseconds) electron pulse with low transverse emittance is generated by the RF-gun. In order to preserve both longitudinal and transverse emittances, great care must be taken in transporting the electron beam from the RF-gun to the linac. We describe the injection line, present first- and second-order lattice studies of the injection line, and study nonlinear effects on the emittance. 11 refs., 4 figs., 4 tabs.

47800 (BNL–42004) **X-ray lithography sources: A review.** Murphy, J.B. Brookhaven National Lab., Upton, NY (USA). 1989. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-890335–251: 13. particle accelerator conference, Chicago, IL (USA), 20-23 Mar 1989). Order Number DE89017610/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Synchrotron from dipole magnets in electron storage rings has emerged as a useful source of x-rays for lithography. To meet the need for these sources numerous groups around the world have embarked on projects to design and construct storage rings for x-ray lithography. Both conventional electromagnets as well as superconducting (SC) dipoles have been incorporated into the various designs. An overview of the worldwide effort to produce commercial x-ray sources will be presented. To better illustrate the elements involved in these sources a closer examination of the Superconducting X-ray Lithography Source Project (SXLS) at BNL will be presented. 11 refs., 1 fig., 5 tabs.

47801 (BNL–42699) **Refurbishment of the vacuum system of the Brookhaven Alternating Gradient Synchrotron.** Welch, K.M.; Tuozzolo, J.E.; McIntyre, G.T.; Skelton, R.; Brown, J.M.; Gill, S.M.; Barry, J. Brookhaven National Lab., Upton, NY (USA). 1989. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-890906–2: 11. international vacuum congress and 7th international conference on solid surfaces, Cologne (Germany, F.R.), 25-29 Sep 1989). Order Number DE90000096/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Three years ago a program was initiated at Brookhaven National Laboratory to upgrade the Alternating Gradient Synchrotron (AGS) vacuum system. The three objectives of this work were to: (1) improve the vacuum system reliability; (2) improve its maintainability; and (3) improve its operating pressure from the present 2-3 x 10^{-7} Torr to $< 10^{-8}$ Torr. This paper discusses how these objectives can be met. 9 refs., 8 figs., 1 tab.

47802 (BNL–42996) **Test fast kicker pulser.** Zhang, W.; Soukas, A.V.; Zhanf, S.Y.; Frey, W.W.; Bunicci, J. Brookhaven National Lab., Upton, NY (USA). 1989. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-890665–47: 7. Institute of Electrical and Electronics Engineers pulsed power conference, Monterey, CA (USA), 12-14 Jun 1989). Order Number DE89017627/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

In this paper, a test pulser of the Brookhaven AGS Booster extraction fast kicker is described. The pulser is projected for both proton and heavy ion operation. A load of total inductance 2.15 μH is used for the test pulser. The PFN voltage is required to be below 40 kV for operation in air. Rise time of the pulse for proton extraction operation is about 120ns up to 97% of full current (1000A),

and, for heavy ion extraction, 160ns up to 98% of full current (1615A). R-C compensation networks are used for pulse front edge sharpening. The flexibility of operation is obtained basically by switching an energy dumping resistor to match or mismatch the PFN impedance. Some comments on stray capacitance and stray inductance effects are included. 3 refs., 10 figs., 2 tabs.

47803 (BNL–42997) **Source options for RHIC.** Prelec, K. Brookhaven National Lab., Upton, NY (USA). 1988. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-881154–9: International symposium on electron beam ion sources and their applications, Upton, NY (USA), 14-18 Nov 1988). Order Number DE89017617/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Conceptual designs of the RHIC facility are matched to the parameters of existing tandem Van de Graaff accelerators at Brookhaven National Laboratory. It has been shown that tandems could produce many ion species up to gold with sufficient intensities for injection into the BNL booster and further acceleration and storage in AGS and RHIC synchrotrons. There have been, however, questions about the long-term performance of tandem accelerators, in view of their reliability, cost of maintenance, and expected requests for higher intensities than they could provide. A study was done in 1986 to investigate the possibility of replacing the tandems with a more compact preinjector situated close to the booster. This report will review the options for such a preinjector. 5 refs., 4 tabs.

47804 (BNL–43100) **Metal and elastomer seal tests for accelerator applications.** Welch, K.M.; McIntyre, G.T.; Tuozzolo, J.E.; Skelton, R.; Pate, D.J.; Gill, S.M. Brookhaven National Lab., Upton, NY (USA). 1989. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-890906–1: 11. international vacuum congress and 7th international conference on solid surfaces, Cologne (Germany, F.R.), 25-29 Sep 1989). Order Number DE89017607/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The vacuum system of the Alternating Gradient Synchrotron (AGS) at Brookhaven National Laboratory has more than a thousand metal vacuum seals. Also, numerous elastomer seals are used throughout the AGS to seal large beam component chambers. An accelerator upgrade program is being implemented to reduce the AGS operating pressure by x100 and improve the reliability of the vacuum system. This paper describes work in progress on metal and elastomer vacuum seals to help meet those two objectives. Tests are reported on the sealing properties of a variety of metal seals used on different sealing surfaces. Results are also given on reversible sorption properties of certain elastomers. 16 refs., 6 figs., 4 tabs.

47805 (DOE/ER/40048–227-L9) **The University of Washington polarized ion source.** Gossett, C.A.; Balsley, D.R.; Harper, G.C.; Bitz, C.M.; Eisenberg, J.K.; Rogers, J.A. Washington Univ., Seattle, WA (USA). Nuclear Physics Lab. [1989]. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-81ER40048. (CONF-890703–17: International conference on ion sources, Berkeley, CA (USA), 9-15 Jul 1989). Order Number DE89017313/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A colliding-beams polarized ion source has been in operation for nuclear physics experiments at the University of Washington tandem-linac facility since late 1987. Thermal beams of polarized atomic hydrogen or deuterium are ionized by charge exchange in collisions with a collinear, fast, neutral cesium beam. Negative ions are extracted and the polarization symmetry axis is precessed to any desired direction in a crossed-field spin precessor. The design of the cesium beam system differs from previous sources in that magnetic deflection and focusing are used and beams of several milliamperes at energies of 40 keV are produced. The source is controlled by a microprocessor based system which is connected via fiber optic links to the main linac control and data acquisition computers. To date, currents of 1 μA and polarizations in excess of 90% have been produced. 3 refs., 2 figs.

47806 (DOE/ER/40048–231-L9) **Beam diagnostics for the University of Washington superconducting booster.** Weitkamp, W.G.; Amsbaugh, J.F.; Connolly, R.C.; Fauska, H.; Irwin, T.J.; Howe, M.A.; LaCroix, J.M.; Leach, D.D.; Readdy, H.P. Washington Univ., Seattle, WA (USA). Nuclear Physics Lab. [1989]. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-81ER40048. (CONF-8905141–4: 5. international conference on electrostatic accelerators and associated boosters, Strasbourg (France), 24-27 May 1989). Order Number DE89017269/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The beam diagnostic system for the University of Washington superconducting booster provides the operator with a visualization of beam shape, position, intensity, time structure, energy and emittance. Control circuitry, interface structure, display graphics and sensors are described. Measurement of the emittance of the tandem injector and the booster for a variety of beams is in progress. 8 refs., 3 figs.

47807 (FNAL-TM–1588) **Scintillating fiber ribbon — tungsten calorimeter.** Bross, A.; Crisler, M.; Kross, B.; Wrbanek, J. Fermi National Accelerator Lab., Batavia, IL (USA). 14 Jul 1989. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. Order Number DE89016705/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We describe an ultra-high density scintillating fiber and tungsten calorimeter used as an active beam-dump for electrons. Data showing the calorimeter response to electrons with momenta between 50 and 350 GeV/c are presented. 9 figs.

47808 (INIS-mf–11515, pp. 48) **Development of ancillary equipment for a linear accelerator.** Schmidt, W. (Vienna Univ. (Austria). Klinik fuer Strahlentherapie und Strahlenbiologie); Hawliczek, R.; Binder, W.; Nedelik, A. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47809 (INIS-mf–11515, pp. 48) **Dosimeter readings reproducibility in water phantom measurements at electron accelerators with a beam scanning system.** Stuecklschweiger, G. (Graz Univ. (Austria). Radiologische Klinik); Poier, E.; Leitner, H. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47810 (INIS-SU–113/A, pp. 32-34) **On a possibility of high-power pulsed source for e^-e^+ production on the base of laser fusion device.** Kotel'nilov, S.S.; Lebo, I.G.; Rozanov, V.B. AN SSSR, Moscow (USSR). Fizicheskij Inst. 1989. (In Russian). (T–23539). In *Experimental and theoretical physics. Collection.* Order Number DE89018003/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Kratkie soobshcheniya po fizike.; v. 1.

It is shown that in case of developed thermonuclear reaction under conditions of laser fusion laser target can become an intensive point source of positrons. The positron source can be used as an injector for accelerators and a source for positron diagnosis in solid state physics. 9 refs.; 1 fig.

47811 (KEK–88-13) **Beam loss monitor for the KEK PS-Booster synchrotron.** Yamaguchi, Hiroshi; Yamane, Isao; Nakagawa, Hidetoshi; Nigorikawa, Kazuyuki. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Feb 1989. 18p. (In Japanese). Order Number DE90701703/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

A new type of beam loss monitor has been developed and used around the KEK PS-Booster synchrotron. The monitor head is a proportional counter filled with a mixture of Argon and Methane gases. The preamplifier is made tolerable to the very high radioactivity during beam acceleration by using a vacuum tube. A lot of this type monitor have been set around the synchrotron. Their output signals are taken into and processed by a VME computer system. They are displayed as a histgram at a desired time on a terminal in the accelerator control room and used for tuning the injection and/or

acceleration condition of the synchrotron. It has been turned out that they are very useful for fine tuning of those conditions. Especially, H^0 and H- beam losses accompanying the H- charge-exchange injection are firstly identified with these beam monitors. Loss of the H- beam which missed the stripping foil has been eliminated by a careful tuning with observing these monitors. As a result, we could eliminate a peak of the residual radioactivity at the vacuum chamber of the ring bending magnet imediately downstream of the injection straight section. (author).

47812 (KEK–88-15) **Workshop on cooling of x-ray monochromators on high power beamlines.** Matsushita, T.; Ishikawa, T. (eds.). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Mar 1989. 212p. (CONF-8808269–: Workshop on cooling of X-ray monochromators on high power beamlines, Tsukuba (Japan), 31 Aug 1988). Order Number DE90701710/JAW. Available from NTIS (US Sales Only), PC A10/MF A01.

This report is a Workshop on Cooling of X-ray Monochromators on High Power Beamlines held on August 31, 1988 at the Photon Factory during the Third International Conference on Synchrotron Radiation Instrumentation (SRI88). On high power beamlines, especially on insertion device beamlines, heating of crystal monochromators is becoming a serious problem: Researchers observe that the intensity of the X-ray beam on the sample is not proportional to the source intensity because of thermal distortion of the monochromator crystal. This problem will be even more serious on beamlines for the next generation X-ray rings. In the very tight program of the SRI88 conference, only 2 speakers were able to give invited talks closely related to this problem in the session of OPTICAL COMPONENTS FOR HIGH POWER BEAMLINES on Wednesday morning of August 31, 1988. We held this workshop in the afternoon of the same day with the intention of offering further opportunities to exchange information on efforts underway at various laboratories and to discuss ideas how to solve this problem. We also intended that the workshop would be a 'follow-up' to the X-ray optics workshop held at ESRF, Grenoble in September 1987, where the importance of crystal cooling was strongly pointed out. There were 32 participants from 7 countries. 12 people represented their experiences and ideas for reducing thermal distortion of crystal monochromators. Following those presentations, there were discussions on collaborations for solving this important problem. The attendees agreed that exchange of information should be continued by holding such meetings at reasonable intervals. (J.P.N.).

47813 (NAC–85-06) **Specifications for k=600 magnetic spectrometer components.** Dostal, P.R.; Cornell, J.C. Council for Scientific and Industrial Research, Faure (South Africa). National Accelerator Centre. 1985. 72p. Available from the National Accelerator Centre, Council for Scientific and Industrial Research, PO Box 72, Faure, 7131, South Africa.

This document specifies components for a k=600 magnetic spectrometer: i.e. Dipoles no.1 and no.2 each with its vacuum chamber, a quadrupole magnet, supporting rotatable structures, track with a central pivot and associated power supplies. Technical specifications are given for the magnet yoke and pole pieces, the vacuum chambers, magnet coil pancakes and trim coils, the spectrometer carriage assemblies, the track assemblies, the quadrupole magnet and the power supplies. The spectrometer will be used for experimental physics using the 200 MeV separated-sector cyclotron of the National Accelerator Centre at Faure.

47814 (ORNL/FTR–2947) **[Discharges and electrical insulation in vacuum, Paris, France, June 27–30, 1988 and visit to Strasbourg, France, July 4, 1988]: Foreign trip report.** Ziegler, N.F. Oak Ridge National Lab., TN (USA). 22 Jul 1988. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017492/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler attended the "13th International Symposium on Discharges and Electrical Insulation in Vacuum" in Paris from June 27–30, 1988, and on July 4, 1988, the traveler visited CRNS in Strasbourg to view and discuss construction of the VIVITRON accelerator.

47815 (SLAC–339) **RF properties of periodic accelerating structures for linear colliders.** Wang, J.W. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jul 1989. 138p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. Order Number DE89016957/JAW. Available from NTIS, PC A08/MF A01; OSTI; INIS; GPO Dep.

With the advent of the SLAC electron-positron linear collider (SLC) in the 100 GeV center-of-mass energy range, research and development work on even higher energy machines of this type has started in several laboratories in the United States, Europe, the Soviet Union and Japan. These linear colliders appear to provide the only promising approach to studying e^+e^- physics at center-of-mass energies approaching 1 TeV. This thesis concerns itself with the study of radio frequency properties of periodic accelerating structures for linear colliders and their interaction with bunched beams. The topics that have been investigated are: experimental measurements of the energy loss of single bunches to longitudinal modes in two types of structures, using an equivalent signal on a coaxial wire to simulate the beam; a method of canceling the energy spread created within a single bunch by longitudinal wakefields, through appropriate shaping of the longitudinal charge distribution of the bunch; derivation of the complete transient beam-loading equation for a train of bunches passing through a constant-gradient accelerator section, with application to the calculation and minimization of multi-bunch energy spread; detailed study of field emission and radio frequency breakdown in disk-loaded structures at S-, C- and X-band frequencies under extremely high-gradient conditions, with special attention to thermal effects, radiation, sparking, emission of gases, surface damage through explosive emission and its possible control through RF-gas processing. 53 refs., 49 figs., 9 tabs.

4304 Storage Rings

Refer also to citation(s) 48311, 48711

47816 (INIS-mf–11515, pp. 126) **Report on the start-up of LEP.** Huebner, K. (European Organization for Nuclear Research, Geneva (Switzerland)). Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47817 (KEK–88-16) **Report of the plan meeting on use of synchrotron radiation from the Tristan Main Ring.** Ando, M.; Kobayakawa, H.; Ohsumi, K. (eds.). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Mar 1989. 120p. (In Japanese). Order Number DE90701702/JAW. Available from NTIS (US Sales Only), PC A06/MF A01.

It has been widely known that activities of synchrotron radiation community in Japan have been grown rapidly in these ten years. Among the technological research and developments, insertion devices to produce new type of synchrotron radiation and optical components to suit the proper purposes of these devices are to be especially mentioned. In order to promote synchrotron radiation research, it is widely understood that intensive use of the Tristan Main Ring is quite essential, because of its extremely high brilliance unattainable for other existing or planned sources. Under these situations we have had participation of not only users who are anxious to use this special radiation but also accelerator physicists and high energy physicists. This report covers following subjects: a capability of the ring as a synchrotron radiation source, several related research topics, a way to realize the utilization of Sr, and perspectives of high energy physics using the Main Ring. (author).

47818 (ORNL/FTR–2872) **[Workshop on ion cooler ring experiments]: Foreign trip report, May 2, 1988–May 13, 1988.** Datz, S. Oak Ridge National Lab., TN (USA). 20 May 1988. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017385/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler participated in a workshop on experiments in cooled heavy-ion storage rings, held in northern Sweden. Discussions centered on the status of rings dedicated to atomic physics, electron beam cooling, beam crystallization, electron-ion recombination, laser cooling, laser-induced recombination, high-resolution laser spectroscopy, and laser molecular ion spectroscopy. The traveler gave two presentations: "Electron-ion Interactions" and "Status of the ORNL-HISTRAP Project." In a visit to CERN, Geneva, Switzerland, the traveler assessed the possibility of carrying out experiments on pair production in ultrarelativistic ion-atom collisions. The traveler found an experimental setup in place which can act as the center for the proposed experimental program and discussed future actions with CERN group.

47819 (ORNL/FTR–2928) **[Design of synchrotron/cooler/storage rings]: Foreign trip report, June 4, 1988–June 17, 1988.** Olsen, D.K. Oak Ridge National Lab., TN (USA). 5 Jul 1988. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017437/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler attended the European Particle Accelerator Conference in Rome, Italy, during which many papers were presented on the small accelerator projects in Europe. In particular, many papers were presented on the European synchrotron/cooler/storage rings under construction, which are similar to the HISTRAP proposal for ORNL. In addition to the formal program, the traveler had informal in-depth discussions on the design principles, construction details, vendors, and problems connected with building these rings. The traveler also visited the LEAR ring in CERN, the SIS and ESR rings at GSI, and the TSR ring at the Heidelberg MPI. The construction of the rings at GSI and Heidelberg are proceeding on schedule.

44 INSTRUMENTATION

4401 Radiation Instrumentation

Refer also to citation(s) 46928, 47012, 47153, 47154, 47961, 48183, 48289, 48296, 48304, 48318, 48319, 48431

47820 (AERE-R–13424) **Measurement of the ISO series of filtered radiations.** Peaple, L.H.J.; Birch, R.; Marshall, M. UKAEA Harwell Lab. (UK). Environmental and Medical Science Div. May 1989. 36p. Available from H.M. Stationery Office, London, price Pound 10.00.

The International Standards Organization (ISO) has described the production of a set of filtered X-ray spectra for calibrating protection-level dosemeters and dose ratemeters, and for determining their response as a function of photon energy. These reference radiations cover a range of energies and dose rates determined by the X-ray tube voltage selected and the degree of filtration employed. An accurate set of the filters specified has been manufactured. The spectra have been measured using a high-resolution planar Ge(Li) detector for energies up to 125 keV, and a NaI(Tl) detector for higher energies. The measured pulse-height distributions have been corrected for Compton scattering, escape of K X-rays and transmission through the crystal. The results for mean photon energy and 1st half-value layer have been compared with the ISO values and other sets of results. The comparison shows that some of the ISO values could be improved. (author).

47821 (ATR–86(8139)-5) **Mechanisms leading to single event upset.** Axness, C.L.; Weaver, H.T.; Fu, J.S.; Koga, R.; Kolasinski, W.A. Sandia Labs., Albuquerque, NM (USA). Mar 1988. 9p. Available from NTIS, PC A02/MF A01.

The SRAM cell recovery time following a 140 MeV Krypton strike on a Sandia SRAM is modeled using a two-dimensional transient numerical simulator and circuit code. Strikes at both n- and p-channel off drains are investigated. Four principle results are obtained. The recovery time after a strike is strongly dependent on the drive of the restoring transistor. A struck off p-channel drain-to-gate capacitive coupling has a significant effect on recovery in SRAM with feedback resistors. Recovery time is approximately linear with LET over LET in the range to 0.4 pC/micrometer. Finally, an experimental n-channel Single Event Upset (SEU) was observed in a Sandia SRAM without feedback resistors.

47822 (BONN-IR–88-43) **Construction of a test cell for the laser calibration of the planar ZEUS drift chambers and studies of algorithms for the analysis of FADC signals.** Dabbous, H. Bonn Univ. (Germany, F.R.). Physikalisches Inst.; Bonn Univ. (Germany, F.R.). Mathematisch-Naturwissenschaftliche Fakultaet. Jul 1988. 70p. (In German). Order Number DE90702768/JAW. Available from NTIS (US Sales Only), PC A04/MF A01.

The planar drift chambers (FTD 1, 2, 3) of the ZEUS forward detector (FDET) will be operated in an inhomogeneous part of the magnetic field produced by the ZEUS solenoid. The calibration of the drift chambers will therefore be performed by measuring the space-drift-time-relation in a small test cell for a variety of combinations of anti E and anti B. This will be done by means of an UV-laser. The test cell is designed to be rotated around 2 axes in the homogeneous anti B-field of a large magnet available at DESY. The laser beam enters the test cell through a quartz window and is appropriately deflected by a system of 3 mirrors. In the second part of this paper several algorithms for the analysis of FADC signals are investigated, in view of optimal spatial and double track resolution. The best results have been obtained with a newly developed method based on digital filtering. (orig.).

47823 (DOE/ER/40048–221-LP) **High-sensitivity hillside results from the Eoet-Wash experiment.** Adelberger, E.G. Washington Univ., Seattle, WA (USA). Dept. of Physics. 1989. 15p. Sponsored by DOE/ER;NSF. DOE Contract AC06-81ER40048. PHY-8719139. (CONF-890199–6: 24. Rencontre de Moriond on tests of fundamental laws in physics, Les Arcs (France), 21-28 Jan 1989). Order Number DE89017312/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Recent improvements to the Eoet-Wash torsion balance are described. With this instument, the differential acceleration of Be and Al toward an earthen hillside is found to be $\Delta a = (4.5 \pm 4.4) \times 10^{-11}$ cm/s^2, which represents a 25-fold improvement over the original Eoet-Wash hillside result. When interpreted as a constraint on a Yukawa interaction coupling to any linear combination of lepton and baryon numbers with a range $\lambda \leq 1.4$ km, our stringent upper limits lie well below the positive effects claimed by Thieberger and Boynton et al. Our new result provides a constraint on the strength of interactions coupling to baryon number almost identical to that established by the Equivalence Principle test of Roll, Krotkov and Dicke, but extends this constraint from ranges of 1 AU down to the radius of the earth. 15 refs., 10 figs.

47824 (DOE/ER/40310–3) **Photon detector for MEGA: Progress report, July 15, 1988–May 1, 1989.** Gagliardi, C.A.; Tribble, R.E. Texas A and M Univ., College Station, TX (USA). Cyclotron Inst. 1989. 22p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER40310. Order Number DE89017358/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

During the summer and fall of 1988, our efforts for MEGA focused on preparing for and taking part in a major engineering test run which took place at LAMPF during September and October. The primary goal of that run was to test a full scale prototype of the innermost MEGA photon pair spectrometer. At the same time, we wanted to investigate background rates that the photon arm will see, both as they impact trigger rates and as they influence our level of multiplexing. This paper describes the results of the test run and describes work on drift chamber and read-out options, light guide fabrication and software developments. 3 refs., 3 figs., 1 tab. (LSP)

47825 (FNAL/C–89/170-E) **A high rate transition radiation detector for particle identification in a hadron beam.** Errede, D.; Sheaff, M.; Fenker, H.; Mantsch, P. Fermi National Accelerator Lab., Batavia, IL (USA). Aug 1989. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03000. (CONF-8904267–1: Symposium on particle identification at high luminosity hadron colliders, Batavia, IL (USA), 5-7 Apr 1989). Order Number DE89016733/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A Transition Radiation Detector (TRD) was built for the purpose of tagging beam particles in a high rate (~2 MHz) 250 GeV/c hadron

beam during data taking for Experiment 769 at Fermilab. The availability of a good "tool kit", including a Monte Carlo program which could reliably predict the detector performance, made it possible to design and build the TRD in approximately one year. Pion or proton samples, each with a small contamination due to the other, could be selected with high efficiency by making cuts on the number of planes of the TRD registering hits for each incident beam particle. The detector is expected to work well to separate kaons from pions in the 500 GeV/c negative beam for E791. 15 refs., 8 figs., 1 tab.

47826 (INIS-mf–11515, pp. 44) **Quartz resonator as radiation detector and energy dosimeter.** Hohenau, W. (Graz Univ., Inst. fuer Experimentalphysik, Graz (Austria)); Krispel, F.; Gross, F. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47827 (INIS-mf–11515, pp. 12) **Positron annihilation radiation in high-temperature superconductors.** Peter, M. (Geneva Univ. (Switzerland). Dept. de Physique de la Matiere Condensee); Manuel, A. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47828 (INIS-mf–11515, pp. 115) **LISA, a time-of-flight spectrometer for measurements of stopping cross sections.** Goiser, R. (Johannes Kepler Univ., Linz (Austria). Inst. fuer Experimentalphysik); Geretschlaeger, M.; Sacher, J.; Stadlbauer, A.; Stohl, K.; Semrad, D. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47829 (JAERI-M–89-042) **Detector system for gamma-ray production cross section measurements and data analysis.** Hasegawa, Kazuo; Mizumoto, Motoharu. Japan Atomic Energy Research Inst., Tokyo (Japan). Apr 1989. 40p. (In Japanese). Order Number DE90701708/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

A detector system for double-differential gamma-ray production cross section measurements has been installed in the JAERI Tandem Accelerator and data analysis computer codes have been developed. Gamma-ray pulse-height spectra have been measured by a 3" dia. x 6" anti-Compton NaI(Tl) detector. Response matrix of the detector has been obtained and evaluated by some pulse-height spectra using standard gamma-ray sources and reaction gamma-rays such as $^{12}C(n, n'\gamma)$, $^{16}O(n, n'\gamma)$, $^{27}Al(p, \gamma)$, and $^{19}F(p, \alpha\gamma)$. Gamma-ray production cross sections have been deduced by means of the unfolding and normalization of neutron flux and number of sample atoms. In this report, outline of the detector system and process of data analysis have been presented. (author).

47830 (N–89-21726, pp. 34) **Angular response calibration of the burst and transient source experiment.** Lestrade, J.P. Alabama Univ., University, AL (USA). Dec 1988. (NASA-CR–183553;NAS–1.26:183553;CONF-8806391–: NASA/ASEE summer faculty fellowship program, Huntsville, AL (USA), 6 Jun 1988). In *Research Reports: 1988 NASA/ASEE Summer Faculty Fellowship Program.* Available from NTIS, PC A99/MF E03.

The Gamma Ray Observatory includes four experiments designed to observe the gamma-ray universe. Laboratory measurements to test the response the Burst and Transient Source Experiment (BATSE) modules to gamma-ray sources that are non-axial were recently completed. The results of these observations are necessary for the correct interpretation of BATSE data obtained after it is put in Earth orbit. The launch is planned for March, 1900. Preliminary analyses of these test data show the presence of a radial dependence to the detector's light collection efficiency. It is proposed to evaluate the importance of this radial response, analyze future experimental data to derive the actual functional dependence on radius, and calculate the net effect on the output spectrum as a function of the angle of incidence.

47831 (N–89-21726, pp. 16) **Fluctuation analysis of relativistic nucleus-nucleus collisions in emulsion chambers.** McGuire, S.C. Alabama Univ., University, AL (USA). Dec 1988. (NASA-CR–183553;NAS–1.26:183553;CONF-8806391–: NASA/ASEE summer faculty fellowship program, Huntsville, AL (USA), 6 Jun 1988). In *Research Reports: 1988 NASA/ASEE Summer Faculty Fellowship Program.* Available from NTIS, PC A99/MF E03.

An analytical technique was developed for identifying enhanced fluctuations in the angular distributions of secondary particles produced from relativistic nucleus-nucleus collisions. The method is applied under the assumption that the masses of the produced particles are small compared to their linear momenta. The importance of particles rests in the fact that enhanced fluctuations in the rapidity distributions is considered to be an experimental signal for the creation of the quark-gluon-plasma (QGP), a state of nuclear matter predicted from the quantum chromodynamics theory (QCD). In the approach, Monte Carlo simulations are employed that make use of a portable random member generator that allow the calculations to be performed on a desk-top computer. The method is illustrated with data taken from high altitude emulsion exposures and is immediately applicable to similar data from accelerator-based emulsion exposures.

47832 (NAC–87-03) **Characteristics of Geiger-Mueller counters used in neutron dosimetry applications.** Jones, D.T.L.; Yudelev, M. Council for Scientific and Industrial Research, Faure (South Africa). National Accelerator Centre. 1987. 22p. Available from the National Accelerator Centre, Council for Scientific and Industrial Research, PO Box 72, Faure, 7131, South Africa.

Because of their low sensitivities to neutrons Geiger-Mueller counters are used, together with tissue equivalent ionization chambers, to determine the gamma dose component in mixed neutron-gamma radiation fields such as are produced in neutron therapy systems. In order that Geiger-Mueller counters can be used in such measurements certain operating characteristics have to be known. The characteristic curves, resolving times and calibration factors for Co^{60} radiation have been measured for several types of Geiger-Mueller counters. 4 tabs., 8 figs., 5 refs.

47833 (ORNL/CSD/FTR–3112) **[Implementation of radiometry quality-control methods for the Safeguards Analytical Laboratory at Seibersdorf, Austria]: Foreign trip report, October 3–21, 1988.** Bayne, C.K. Oak Ridge National Lab., TN (USA). 14 Nov 1988. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017361/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This visit to the Safeguards Analytical Laboratory (SAL) concentrated on implementation quality-assurance (QA) and quality-control (QC) procedures for radiometry measurements. Multivariate statistical procedures to compare measurements from mass spectrometry and gamma-ray spectrometry were used to analyze 230 observations from seven sources of plutonium material. These comparisons showed that the results depended on the type of material and the method of estimating ^{242}Pu. Procedures to estimate the pocket sensitivity for multicollector mass spectrometers were also investigated. A method was developed that estimated pocket sensitivity after adjusting for ion-density decays with time and mass differences. The QC charts implemented in May 1988 have already been useful for detecting data-entry errors, arithmetic errors, and an overheating amplifier on a mass spectrometer. 8 refs., 1 fig.

47834 (ORNL/FTR–2726) **[Data acquisition of WA80 calorimeters with ^{32}S beams]: Foreign trip report, September 11, 1987–October 13, 1987.** Obenshain, F.E.; Young, G.R. Oak Ridge National Lab., TN (USA). 27 Oct 1987. 3p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017406/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The purpose of this assignment was to operate all WA80 calorimeters for data acquisition with the ^{32}S beam at CERN, Geneva, Switzerland. The major work of restarting the system after

a six- month shutdown was done in June, July, and August. The remaining tasks were to set the gain of the system and to take data on Au, Ag, Cu, and Al targets with the 6400-GeV sulphur beam from the SPS accelerator at CERN. This assignment was completed successfully at 8:00 a.m. on the 13th of October.

47835 (ORNL/FTR–2955) **[International conference on applications of nuclear techniques, Crete, Greece, and visit to Utrecht, Netherlands, June 27–July 8, 1988]: Foreign trip report.** Raman, S. Oak Ridge National Lab., TN (USA). 22 Jun 1988. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017488/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler attended the International Conference on Applications of Nuclear Techniques (Crete, Greece, June 26–July 1, 1988) where he presented an invited talk. This report gives his general impressions of the topics discussed at this conference. Following this conference, the traveler visited the University of Utrecht (the Netherlands) to further a cooperative research program that has been established with this university.

47836 (ORNL/FTR–3237) **[WA80 collaboration, Muenster, W. Germany, April 17–21, 1989]: Foreign trip report.** Young, G.R. Oak Ridge National Lab., TN (USA). 11 May 1989. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017350/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler attended a WA80 collaboration meeting held at the University of Muenster, FRG. The status of various experimental analyses was reviewed and discussed, as was the status of various papers in preparation. Plans for a joint NA35-WA80 proposal to use the lead beams to be available at the SPS in 1993 were advanced in a meeting which included several WA80 persons plus Reinhard Stock of NA35 and Rudolf Bock of GSI. Plans for a prototype of a high-resolution photon calorimeter were made. ORNL is asked to prepare much of this for a test run in December 1989. Further plans for the 1990 and 1991 extended beam times at CERN with ^{32}S were made. ORNL is asked to participate in a large upgrade of the present trigger and to collaborate with Muenster in a large upgrade and expansion of the present photon calorimeter. Other items include a rearrangement of the experimental area (GSI), new multiplicity counters (Lund-LBL), and a new data-acquisition system (GSI-Muenster).

47837 (PNL–6952) **Hanford radiological protection support services annual report for 1988.** Lyon, M.; Fix, J.J.; Kenoyer, J.L.; Leonowich, J.A.; Palmer, H.E.; Sula, M.J. Pacific Northwest Lab., Richland, WA (USA). Jun 1989. 70p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. Order Number DE89016807/JAW. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

The report documents the performance of certain radiological protection sitewide services during calendar year (CY) 1988 by Pacific Northwest Laboratory (PNL) in support of the US Department of Energy-Richland Operations Office (DOE-RL) and contractor activities on the Hanford Site. The routine program for each service is discussed along with any significant program changes and tasks, investigations, and studies performed in support of each program. Other related activities such as publications, presentations, and memberships on standard or industry committees are also listed. The programs covered provide services in the areas of (1) internal dosimetry, (2) in vivo measurements, (3) external dosimetry, (4) instrument calibration and evaluation, (5) calibration of radiation sources traceable to the National Institute of Standards and Technology (NIST) (formerly the National Bureau of Standards), and (6) radiological records. 23 refs., 15 figs., 15 tabs.

47838 (UCRL–100784) **A microchannel plate intensified, subnanosecond, x-ray imaging camera.** Carter, M.R.; McKinley, B.J.; Tirsell, K.G. Lawrence Livermore National Lab., CA (USA). Jul 1989. 18p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890809–1: 9. international conference on vacuum ultraviolet radiation physics, Honolulu, HI (USA), 14-18 Aug 1989). Order Number DE89017781/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We have developed a microchannel plate intensified, subnanosecond x-ray detector for x-ray imaging experiments. It consists of an x-ray photocathode, a microchannel plate, electrostatic focusing optics and a subnanosecond phosphor. The detector is used for one dimensional imaging and spectroscopic measurements. Signals are recorded using either a one dimensional Reticon camera or a streak camera. The microchannel plates employ an x-ray photocathode (CuI or CsI) deposited on the front surface of the microchannel plate to enhance their soft x-ray efficiency. Electrostatic focusing of the electrons exiting the microchannel plate also enhances the gain of the detector by an order of magnitude. The electrons are accelerated to 20 kV before striking a fast phosphor (Indium doped Cadmium Sulfide). The detector output is coupled to a Reticon camera or a streak camera with a fiber optic array. We have built and calibrated more than twenty microchannel plate intensified detectors. Efficiencies in excess of 1000 (Watts/cm^2 output per Watt/cm^2 input) have been demonstrated. The time response of the detector is less than 500 ps. The efficiency of the CuI and CsI x-ray photocathodes have been measured from 450 eV to 1300 eV at the Stanford Synchrotron Radiation Laboratory. Data are presented on the efficiency, time response, spectral response and the spatial resolution of the detectors. 8 refs., 12 figs.

47839 **Some TPC measurements in an oxygen beam at the AGS.** Love, W.A. (Brookhaven National Lab., Upton, NY (USA)); Etkin, A.; Foley, K.J.; Hackenburg, R.W.; Longacre, R.S.; Morris, T.W.; Platner, E.D.; Saulys, A.C.; Bonner, B.E.; Buchanan, J.A. E-810 Collaboration. *Nuclear Physics [Section] A (Netherlands)*, 498: 498 (10 Jul 1989). DOE Contract AC02-76CH00016;AC02-83ER40107;AS05-81ER40032;AC02- (CONF-8809203–: Quark Matter '88: 7th international conference on ultrarelativistic nucleus-nucleus collisions, Lenox, MA (USA), 26-30 Sep 1988).

The principal detector for AGS Experiment 810 is a Time Projection Chamber (TPC) in which it is intended to measure momenta and angles of a major fraction of the charged particles from each light ion collision. This report describes the results of a test of a prototype of the TPC in a beam of (14.6x16=233.6 GeV/c) oxygen ions run in June of this year. (orig.).

4402 Radiation Effects On Instrument Components, Instruments, Or Electronic Systems

47840 (INIS-mf–11515, pp. 66) **Recombination centres in electron- and neutron irradiated Si diodes.** Fromherz, T. (Johannes Kepler Univ., Linz (Austria). Inst. fuer Experimentalphysik); Palmetshofer, L. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47841 (UCID–21687) **HPM [high power microwave] testing of electronic components.** Antinone, R.; Ng, W.C. Lawrence Livermore National Lab., CA (USA). 10 May 1989. 79p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. Order Number DE89016682/JAW. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This report documents the results of a study of high power microwave (HPM) vulnerability of electronic components commonly used in weapon systems. The study was carried out at the Lawrence Livermore National Laboratory from August through October 1988. The objective of this study was to determine the threshold levels for upset or disturbance and damage of the devices under test (DUT). In these tests pulsed microwave energy was directly injected into the terminal of the DUT and in most cases a 50-ohm microstrip test fixture was used to ensure that 50-ohm transmission was maintained as close to the DUT as possible. 3 refs., 41 figs., 10 tabs.

47842 (UCID–21739) **EMI [electromagnetic interference] potential of proposed 115KV line near B-691.** Latorre, V.R.; Wythe, D.M. Lawrence Livermore National Lab., CA (USA). 27 Jul 1989.

40p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE89016675/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Laser Operated Diamond Turning Machine (LODTM) is housed in Building 691. This facility contains electronic measurement and control systems which could be susceptible to interfering electromagnetic interference (EMI) generated by sources external to B-691. In particular, concern has been expressed that such harmful EMI signals could be produced by the proposed WAPA 115KV feeder line which would be routed approximately 30 feet from the East side of the facility. Also, there has been some concern expressed about the effects of the resulting electromagnetic (EM) fields on personnel in the proximity of the power line. Since it is necessary to measure the EM fields to ascertain if a hazard does indeed exist, and since we in ERD have been performing such field measurements for many years, we were contacted to determine the field levels from the line that might be expected inside and close to B-691. This report describes our approach, equipment and calibration procedures, analysis techniques used, results, and suggestions for future work in related areas. 9 refs., 41 figs.

4403 Miscellaneous Instruments

Refer also to citation(s) 46836, 47079, 47243, 47721, 47722, 47807, 48160, 48437, 48730

47843 (DOE/CE/15401–T4) **A miniature inexpensive oxygen sensing element: Quarterly review.** Arenz, R.W. CeramPhysics, Inc., Westerville, OH (USA). 30 Jun 1989. 5p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract FG01-88CE15401. Order Number DE89014439/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

MEASURING INSTRUMENTS/design; PROGRESS REPORT; OXYGEN; SEALING MATERIALS; SEALS; CERAMICS; JOINING; DESIGN

47844 (INIS-SU–107/A, pp. 203) **Small-size spectrometers automated on the base of microprocessors and microcomputers.** Linev, V.N. (Belorusskij Gosudarstvennyj Univ., Minsk (Byelorussian SSR)); Fursa, E.Ya. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.

Short Communication

47845 (LA-SUB–89-6) **Report on design work on the LAMPF QD(-Q) spectrometer: Final report.** Deuteron, Inc., Winchester, MA (USA). 20 May 1988. 20p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. Order Number DE89017321/JAW. Available from NTIS, PC A03/MF A01 - OSTI.

This work consists of finalizing the ion optics of a Medium- Resolution Spectrometer (MRS) and providing support for the LANL engineering staff in constructing the instrument. The original ion-optics work was carried out by Deuteron. The report of this earlier work discusses four different solution for the MRS. The LANL staff selected one of these solutions, the QD(-Q), for construction. The contributions of Deuteron Inc in finalizing the design are described here. 4 figs.

47846 (LA-UR–89-2657) **Interferometry and high speed photography of laser-driven flyer plates.** Paisley, D.L.; Montoya, N.I.; Stahl, D.B.; Garcia, I.A. Los Alamos National Lab., NM (USA). [1989]. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-8908140–1: SPIE conference on high speed photography, videography, and photonics, San Diego, CA (USA), 8 Aug 1989). Order Number DE89016990/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Laser-driven thin (2-10-μ thick) plates of aluminum and copper are accelerated to velocities $\geq$5 km/s by a 1.06-μ wavelength Nd:YAG 8-10 ns FWHM laser pulse at power densities 0.7-4.0 GW/cm^2. Accelerations $\geq 10^9$ km/s^2 have been achieved. The acceleration and velocity of these 0.4-1.0-mm-diameter plates are experimentally recorded by velocity interferometry (VISAR) and the planarity of impact by streak photography. 6 refs., 7 figs.

47847 (ORNL/FTR–2829) **[Electron-beam induced spectroscopies at very high spatial resolution]: Foreign trip report, April 26–March 12, 1988.** Bentley, J. Oak Ridge National Lab., TN (USA). 28 Mar 1988. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017303/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

At the Workshop on "Electron-Beam Induced Spectroscopies at Very High Spatial Resolution," held in Aussois, France, the state of the art and where the field is (or should be) going was treated in depth. At the workshop the traveler made oral presentations on ionization localization effects on ALCHEMI measurements of Ni_3Al-based alloys, the complementary use of atom-probe field-ion microscopy, a rapporteur summary of the session on X-ray detectors, and a poster presentation on EXELFS characterization of amorphous and crystalline SiC and Al_2O_3. Much useful information was obtained at the workshop that will directly influence the analytical electron microscopy research at ORNL. In visits to the Ecole Polytechnique Federale Lausanne, Switzerland, the the Centre d'Etudes Nucleaires de Grenoble, France, and to the Universite Paris-Sud, Centre d'Orsay, France, the performance of and research conducted with Philips EM430ST, JEM 4000EX, and VG HB5 instruments with various attachments and modifications were discussed. Demonstration provided by the hosts on these special instruments were particularly useful.

47848 (SAND–89-1784) **Video imaging systems: A survey.** Kefauver, H.L. Sandia National Labs., Albuquerque, NM (USA). Jul 1989. 244p. Sponsored by U.S. DOE Management & Administration. DOE Contract AC04-76DP00789. Order Number DE89016920/JAW. Available from NTIS, PC A10/MF A01 - OSTI; GPO Dep.

Recent technological advances in the field of electronics have made video imaging a viable substitute for the traditional Polaroid™ picture used to create photo ID credentials. New families of hardware and software products, when integrated into a system, provide an exciting and powerful toll which can be used simply to make badges or enhance an access control system. This report is designed to make the reader aware of who is currently in this business and compare their capabilities.

47849 (UCRL–21166) **Microwave signal detection using modulation of polymeric optical waveguides: Final report, March–September 1988.** Kowel, S.T.; Knoesen, A.; Eldering, C.A.; Mortazavi, M.A. California Univ., Davis, CA (USA). Jan 1989. 50p. Sponsored by DOD;DOE/DP;NSF. DOE Contract W-7405-ENG-48. Order Number DE89017545/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Polymeric Ultrathin Films Program (PUFS) was initiated at UCD during the Fall of 1984. It is an multidisciplinary program of research and graduate education involving faculty from the Department of Electrical and Computer Engineering (Stephen T. Kowel, Andrew Dienes, and Andre Knoesen), the Department of Chemical Engineering (Pieter Stoeve and Brian G. Higgins), the Department of Physics (Lawrence B. Coleman), and the Department of Applied Science (Yin Yeh), and their students. Since the Summer of 1986, a close collaboration has developed with scientists at the Chemistry Division, Naval Weapons Center, China Lake, CA. Thus, the program includes efforts by Dr. Geoffrey Lindsay and Dr. James Hoover, in organic and synthetic chemistry, as well as deposition of ultrathin films, evaluation of film properties, and applications work carried our at UCD. The primary focus of our work is film systems for opto-electronics, especially optical signal conditioning, hybrid computing, and sensing. Some project elements devoted to evaluation of optical fibers and planar waveguides have been performed by professor Richard Selfridge in the Department of Electrical and Computer Engineering at Brigham Young University, Provo, Utah. Support has come from the Air Force Weapons Laboratory, Rome Air Development Center, Lawrence Livermore National Laboratory, and the National Science Foundation.

47850 (UCRL–101721) **High resolution x-ray spectroscopy using germanium microcalorimeters.** Silver, E.; Labov, S.; Goulding, F.; Madden, N.; Landis, D.; Beeman, J.; Pfafman, T.; Melkonian, L.; Millett, I.; Wai, Y. Lawrence Livermore National Lab., CA (USA). 26 Jul 1989. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890836–14: 33. SPIE annual international technical symposium on optical and optoelectronic applied science and engineering, San Diego, CA (USA), 6-11 Aug 1989). Order Number DE89017784/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We are developing cryogenically-cooled microcalorimeters for high resolution x-ray spectroscopy. Using neutron transmutation-doped (NTD) germanium thermistors as the x-ray absorber, we have achieved an energy resolution of 70 eV at a temperature of 0.3 K. There is strong evidence for incomplete conversion of x-ray energy into thermal energy when the photon is absorbed in the bulk of the NTD germanium. We believe that the nonthermal energy component manifests as ionization, none of which is converted to thermal energy within the measurement time of the system. As in an ionization detector, the division between ionization and thermal energy is statistically uncertain and leads to a lower limit to the energy resolution measured using either the thermal or ionization signal. Complete conversion to thermal energy with no loss to ionization appears to occur when the x-ray is absorbed by the metallic contacts. This will be discussed in the context of our most recent 0.3 K experiments. 20 refs., 11 figs.

47851 An automated flow calorimeter for heat capacity and enthalpy measurements. Sandarusi, J.A. (Colorado School of Mines, Golden (USA)); Yesavage, V.F. *International Journal of Thermophysics (USA),* 9(6): 993-1002 (Nov 1988). DOE Contract FG02-87ER13683. (CONF-880606–: 10. symposium on thermophysical properties, Gaithersburg, MD (USA), 20-23 Jun 1988).

An automated flow calorimeter has been developed for the measurement of heat capacity and latent enthalpies of fluids at elevated temperatures (300-700 K) and pressure (< 30 MPa) with a design accuracy of 0.1%. The method of measurement is the traditional electrical power input flow calorimeter, utilizing a precision metering pump, which eliminates the need for flow-rate monitoring. The calorimeter cell uses a unique concentric coil design with passive metal radiation shields and active guard heaters to minimize heat leakage, eliminate the traditional constant-temperature bath, and facilitate easy component replacement. An additional feature of the instrument is a complete automation system, greatly simplifying operation of the apparatus. A novel multitasking software scheme allows a single microcomputer simultaneously to control all system temperatures, provide continuous monitoring and updates on system status, and log data. Preliminary results for liquid water mean heat capacities show the equipment to be performing satisfactorily, with data accuracies of better than ±0.3%. Minor equipment modifications and better thermometry are required to reduce systemic errors and to achieve the designed operational range.

4404 Well Logging Instrumentation

47852 (SAND–89-0166) **Prototype Borehole Directional Radar System.** Chang, Hsi-Tien. Sandia National Labs., Albuquerque, NM (USA). Sep 1989. 69p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC04-76DP00789. Order Number DE89016926/JAW. Available from NTIS, PC A04/MF A01 - OSTI.

This report summarizes the progress of the Borehole Directional Radar (BDR) System, which is a high-power, high-resolution tool that is being developed to locate lithologic layers or fractures away from a wellbore. The key to the tool's potential is its ability to accurately measure distance and direction of a lithologic discontinuity underground. The results of two field tests in 1988 are presented. The report also discusses the deficiencies of the current system, and a proposed upgrade. Finally, possible other applications of the BDR System are outlined, including (1) locating gas and oil reservoirs below a salt dome, (2) determining the integrity of underground structures (e.g., Strategic Petroleum Reserve, Nuclear Waste Repository Site), and (3) verifying underground nuclear tests. 25 refs., 14 figs.

45 EXPLOSIONS AND EXPLOSIVES

4501 Chemical

47853 (AD-A–207557/0/XAB) **Application of crystal-lattice disintegration criteria to compute minimum shock-induced reactive conditions in solid explosives and inert materials. Final technical report, August 1987-August 1988.** Billingsley, J.P.; Adams, C.L. Army Missile Command, Redstone Arsenal, AL (USA). Systems Simulation and Development Directorate. Mar 1989. 34p. (AMSMI/TR-RD-SS–88-10). Available from NTIS, PC A03/MF A01.

Threshold-particle-velocity criteria derived by E. R. Fitzgerald (2) for the beginning of crystal-lattice breakup and disintegration was applied to shocked explosives and an inert material. In shocked explosives, reactions leading to detonation occur above a certain threshold magnitude. The computed crystal-lattice breakup shock pressures compare rather well with observed experimental threshold shock pressures for six high explosives. The six explosives are: Comp-B3, Comp-B, TNT, PBX-9404, Tetryl, and H-6. In addition, the crystal-lattice breakup criteria provides an explanation for the observed lowering of the detonation threshold shock pressure as the explosives are made more porous or less dense. Finally, the shock pressures, at which output from thermocouples embedded in shocked materials (PBX-9404 and Plexiglass) increases dramatically, compare favorable with predictions based on crystal-lattice disintegration criteria. Consequently, it is tentatively concluded that crystal lattice breakup, or self-sustained phonon fission as Fitzgerald calls it, is responsible for the initiation of detonation in shocked explosives and enhanced thermocouple output in shocked materials. Several recommendations for future work are given. (Author).

47854 (BUMINES–9017795) **Hazards of explosives dusts: Internal report No. 4784.** Bureau of Mines, Pittsburgh, PA (USA). Pittsburgh Research Center. Aug 1989. 35p. Sponsored by U.S. Department of the Interior. Available from OSTI; Bureau of Mines, Pittsburgh Research Center, Pittsburgh, PA 15222.

At the requests of the Departments of Energy and Defense, the Bureau of Mines has investigated the hazards of military explosives dispersed as dust clouds in a 20-L test chamber. For purposes of personnel safety, the spark ignitability of the explosives in the form of unconfined dust layers was also studied. The 20-L data show that most of the explosives dusts were capable of sustaining explosions as dust clouds dispersed in air and some dusts were even capable of sustaining explosions when dispersed in nitrogen. The finest sizes of explosives dusts were less reactive than the larger sizes; this is opposite to the particle size effect observed previously for the pure fuel dusts. The data for the explosives dusts were compared to those for pure fuel dusts. 31 refs., 47 figs., 10 tabs.

47855 (LA–11570-MS) **Indexes for the proceedings of the symposia (international) on detonation, 1951 through 1985.** Crane, S.L.; Deal, W.E.; Ramsay, J.B.; Takala, B.E. Los Alamos National Lab., NM (USA). Aug 1989. 92p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE89015178/JAW. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

The Proceedings of the eight Detonation Symposia have become the major archival source of information of international research in explosive phenomenology, theory, experimental techniques, numerical modeling, and high-rate reaction chemistry. In many cases, they contain the original reference or the only reference to major progress in the field. For some papers, the information is more complete than the complementary article appearing in a formal journal, yet for others, authors elected to publish only an abstract in the Proceedings. For the large majority of papers, the Symposia Proceedings provide the published reference to a body of work. However, no indexes exist for any of the Proceedings, making it difficult to locate a reference or to perform a preliminary literature search. This report indexes the eight existing Proceedings of the Detonation Symposia by paper titles, topic phrases, authors, and first appearance of acronyms and code names. It is a dynamic effort that we expect to supersede by future versions.

47856 (LA-UR–89-2773) **Carbon in detonations.** Johnson, J.D. Los Alamos National Lab., NM (USA). 1989. 9p. Sponsored by

U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-890812–40: American Physical Society topical conference on shock compression of condensed matter, Albuquerque, NM (USA), 14-17 Aug 1989). Order Number DE89016037/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

We review three principal results from a five year study of carbon and its properties in detonations and discuss the implications of these results to the behavior of explosives. We first present a new determination of the carbon melt line from release wave velocity measurements in the shocked state. We then outline a colloidal theory of carbon clustering which from diffusion limited coagulation predicts a slow energy release rate for the carbon chemistry. Finally, we show the results from the examination of recovered soot. Here we see support for the colloid theory and find the diamond phase of carbon. The main theme of this paper is that the carbon in detonation products is in the form of a colloidal suspension of carbon clusters which grow through diffusion limited collisions. Even the final state is not bulk graphite or diamond, but is a collection of small, less than 100 ÅA, diamond and graphitic clusters. 23 refs., 4 figs.

47857 (LA-UR–89-2783) **KIVA reactive hydrodynamics code applied to detonations in high vacuum.** Greiner, N.R. Los Alamos National Lab., NM (USA). [1989]. 33p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-8909182–1: NATO advanced study institute on chemistry and physics of molecular processes in energetic materials, Sicily (Italy), 2-15 Sep 1989). Order Number DE89016979/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The KIVA reactive hydrodynamics code has been adapted for modeling detonation hydrodynamics in a high vacuum. Adiabatic cooling rapidly freezes detonation reactions as a result of free expansion into the vacuum. After further expansion, a molecular beam of the products is admitted without disturbance into a drift tube, where the products are analyzed with a mass spectrometer. This paper explains how the model is used for interpretation and design of experiments for detonation chemistry. Modeling of experimental hydrodynamic characterization by laser-schlieren imaging and model-aided mapping that will link chemical composition data to particular volume elements in the explosive charge are also discussed.

47858 (LA-UR–89-2898) **Lagrangian analysis of MIV [Magnetic Impulse-Velocity] gauge experiments on PBX 9502 using the mass-displacement moment function.** Forest, C.A.; Wackerle, J.; Dick, J.J.; Sheffield, S.A.; Pettit, D.R. Los Alamos National Lab., NM (USA). [1989]. 24p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-890811–28: 9. international symposium on detonation, Portland, OR (USA), 28 Aug - 1 sep 1989). Order Number DE89016612/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Magnetic Impulse-Velocity (MIV) gauges were used to measure the impulse and particle-velocity fields at discrete Lagrangian positions in two samples of the TATB explosive PBX 9502. Each sample was shock driven by a 6.4 mm layer of reacting superfine TATB (ρ_0 = 1.80 g/cm^3), which was itself shocked by a gas driven projectile. The gauge histories of particle velocity and impulse, and the derived displacement history were simultaneously fit to the partial derivatives of the mass-displacement moment function employing a single set of parameters. (The function also gives volume, energy, pressure and their time derivatives.) With an assumed mixture equation of state, the reaction extent and reaction rate were calculated. The two experiments were compared and rate correlations were examined. 8 refs.

47859 (LA-UR–89-2936) **Sensitivity relationships in energetic materials.** Storm, C.B.; Stine, J.R.; Kramer, J.F. Los Alamos National Lab., NM (USA). [1989]. 36p. Sponsored by DOD;DOE/DP. DOE Contract W-7405-ENG-36. (CONF-8909182–2: NATO advanced study institute on chemistry and physics of molecular processes in energetic materials, Sicily (Italy), 2-15 Sep 1989). Order Number DE89016967/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In searching for new explosives one is most concerned with performance (detonation velocity and pressure), thermal properties, and sensitivity. Whether a new candidate explosive is ultimately widely used may well be determined by other factors, such as cost, toxicity, melting point, etc., but the initial research effort is guided by the trinity of performance, thermal stability, and sensitivity. This presents a difficult multifactoral problem in assessing the various molecular properties that contribute to each of these principal selection criteria. For instance, detonation velocity is affected by density, elemental composition, and heat of formation. These factors must be varied together in such a way as to maximize the combined effect on performance. We have shown a relationship between impact and shock sensitivity and illustrated how a sensitivity index based on oxygen balance can be used to estimate sensitivity in closely related series of molecules. It is shown that the critical temperature of an explosive calculated by the Frank-Kamenetskii equation correlated fairly well with the shock sensitivity of the material. This supports the idea that the shock or impact initiation of an explosive is primarily a thermal event and not dominated by pressure driven chemistry. The concept of the "trigger linkage" in explosives is discussed and it is pointed out that insensitive explosives will require early chemistry that is thermomechanically neutral or endothermic and leads to the build-up of later strongly exothermic chemistry.

47860 (SAND–89-0344C) **Powder morphology effects in the ignition of titanium-based pyrotechnics.** Erickson, K.L.; Skocypec, R.D.; Rogers, J.W. Jr. Sandia National Labs., Albuquerque, NM (USA). 1989. 16p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-8909113–4: 14. international pyrotechnics seminar, Jersey (UK), 18-22 Sep 1989). Order Number DE89017229/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The influence of powder morphology on the thermal ignition of uniformly heated titanium powders was examined theoretically using expressions for fundamental heat transfer and chemical reaction mechanisms. The basic effect of powder morphology is that critical conditions exist for which small relative decreases in the initial sample mass result in a major portion of the reactive surface area being depleted before the sample temperature is sufficient for a self-propagating reaction to occur. In these cases, ignition temperatures increase by 100 to 200 K relative to those for slightly larger samples. Similar effects are observed for small relative decreases in the heating rate. It appears that sample morphology accounts for similar effects that were previously observed experimentally. A practical aspect of powder morphology is the particle size distribution of the "fines" in different powder lots. A very small difference in particle size distribution can shift ignition temperatures by 100 K or more. 11 refs., 9 figs., 1 tab.

47861 (SAND–89-1069C) **Raman spectroscopic studies of shock-compressed nitromethane and nitromethane-d_3.** Renlund, A.M.; Trott, W.M. Sandia National Labs., Albuquerque, NM (USA). [1989]. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-890812–35: American Physical Society topical conference on shock compression of condensed matter, Albuquerque, NM (USA), 14-17 Aug 1989). Order Number DE89016812/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Single-pulse Raman spectroscopy has been used to examine the effect of shock compression on the C-N stretching modes near 900 cm^{-1} in a 50/50 mixture of nitromethane (NM) and perdeutero nitromethane (NM-d_3). Samples were shocked in a single step to pressures as high as 6.8 GPa using a compressed gas gun driver. Spectra up to 5.5 GPa showed he expected pressure-induced shifting of the Raman frequencies; at higher pressures the lines were significantly broadened and the frequency shift was reversed, indicating the initial stages of reaction. In no instance did we see significant isotopic exchange as would be evidenced by alteration of the relative line intensities. 6 refs., 3 figs., 1 tab.

47862 (UCID–21692) **Remedial investigation of the High Explosives Burn Pit facility, Building 829 complex, Lawrence Livermore National Laboratory site 300.** Environmental restoration series. Webster-Scholten, C.P.; Crow, N.B. Lawrence Livermore National Lab., CA (USA). Aug 1989. 41p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE89017741/JAW. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

To assess any impact on the environment resulting from operations at the High Explosives (HE) Burn Pits at Lawrence Livermore National Laboratory (LLNL) Site 300, we evaluated the soil, rock,

and ground water beneath the burn pit facility. Between November 16, 1986, and January 12, 1987, we drilled eight exploratory holes; one was converted to a monitor well, and another was converted to a piezometer. Seven holes were drilled, geologically logged, and sampled to determine the concentration and extent of substances that may have infiltrated to the subsurface from the burn pits. The eighth hole was completed as a monitor well but was not sampled, and no detailed log was prepared. Electric logging was performed in one exploratory hole further evaluate the geologic conditions. 27 refs., 4 figs., 6 tabs.

47863 (UCRL–100835) **VISAR wave profile measurements in supra-compressed HE.** Erskine, D.J.; Green, L.; Tarver, C. Lawrence Livermore National Lab., CA (USA). Aug 1989. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890812–43: American Physical Society topical conference on shock compression of condensed matter, Albuquerque, NM (USA), 14-17 Aug 1989). Order Number DE89017736/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Using a VISAR velocimeter with nanosecond time resolution, wave profiles of the reaction zone were measured in planar TNT and 92.5/7.5 TATB/KEL-F samples impacted by flyer plates from a two-stage gas gun, at shock pressures exceeding the detonation pressure. The results indicate that for increasing piston-supported pressures the difference between inert and reaction product Hugoniots becomes very small, For TNT, the reaction zone is fairly well defined and does not extend beyond 150 ns. 7 refs., 4 figs.

47864 (UCRL–101617) **Shock initiation of LX-17 as a function of its initial temperature.** Urtiew, P.A.; Erickson, L.M.; Aldis, D.F.; Tarver, C.M. Lawrence Livermore National Lab., CA (USA). 24 Jul 1989. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890811–29: 9. international symposium on detonation, Portland, OR (USA), 28 Aug - 1 sep 1989). Order Number DE89017730/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The TATB-based pressed solid explosive LX-17 has been demonstrated to exhibit significant differences in shock sensitivity as its initial temperature is varied from −54°C to +88°C. In this combined experimental-computational study, embedded gauges were used to measure the particle velocity and pressure histories in reacting LX-17 at various initial shock pressures and time durations at three initial temperatures: cold (−54°C), ambient (25°C), and hot (88°C). The ignition and growth reactive flow computer model, which had previously been normalized to a great deal of embedded gauge and other shock initiation data for ambient temperature LX-17, was then used to determine the differences in chemical reaction rates which are required to calculate the cold and hot LX-17 data. The embedded gauge records clearly demonstrate that during shock compression at colder temperature there are fewer ignition hot spots and that the growth of reaction rates from these hot spots is also slower. At higher temperatures the ignition is more vigorous and the growth of reaction rates is also faster. However, the transition to detonation occurs as rapidly in cold LX-17 as it does in ambient or hot LX-17. The changes in the three reaction rate terms of the ignition and growth model necessary for accurate simulations are consistent with these experimental observations. 34 refs., 15 figs., 1 tab.

47865 (UCRL–101680) **Model calculations and experimental measurements of the response of HMX porous beds to deflagration and shock.** Aldis, D.F.; Lee, E.L.; Simpson, R.L.; Weston, A.M. Lawrence Livermore National Lab., CA (USA). 4 Aug 1989. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890811–30: 9. international symposium on detonation, Portland, OR (USA), 28 Aug - 1 sep 1989). Order Number DE89017885/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The experimental research on the response of porous beds of HMX has yielded a body of evidence which includes accurate measurements of gas flow, compaction ratio, detonation transit distance and time. As the experimental research has progressed, we have developed a 1D numerical model (1DUCT) to describe this response in a special hydrodynamic code in which the gas phase is allowed to flow through a solid phase. Gas phase relative velocity is limited to be subsonic. In addition we have developed special constitutive and fluid EOS models (2DUCT) for use with the 2D Lagrange hydrocode, DYNA2D, in which there is no cell to cell gas phase mass transfer. Our study strategy was to analyze several, very different experiments to derive values of phenomenological parameters in the model. These experiments include squib ignited events where relative gas flow is important and compression ignition tests where it is not. 26 refs., 18 figs.

4502 Nuclear

Refer also to citation(s) 47016, 47245, 47319, 47320, 47855, 47915

47866 (AD-A–206002/8/XAB) **Communication facility EMP (electromagnetic pulse) assessment. Topical report, 1 September 1975-30 March 1979.** Boeing Aerospace Co., Seattle, WA (USA). 30 Mar 1979. 54p. Available from NTIS, PC A04/MF A01.

The Commander-in-Chief and the Defense Nuclear Agency (DNA) have undertaken an Assessment of Communications for Hardening to Electromagnetic Pulse to assess the vulnerability of the Command's Control, Communication, and Computer (C4) Networks to electromagnetic pulses from high-altitude nuclear bursts and to provide recommendations for hardening as may be required. Networks are used to link with the National Command Authority (NCA), subordinate and component headquarters, and the forces. The Boeing Aerospace Company has developed and validated analytical techniques to predict the functional responses of a communication facility to the environment produced by an electromagnetic pulse (EMP) scenario. The analytical capability has been applied to selected elements of the C4 Networks to develop response predictions in terms of upset and damage of facility equipment and functional impairments of facility communications capabilities.

47867 (AD-A–207419/3/XAB) **Visibility in an atmospheric nuclear dust cloud. Master's thesis.** Wuchte, T.J. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering. Mar 1989. 73p. (AFIT/GNE/ENP–89M-9). Available from NTIS, PC A04/MF A01.

The purpose of this study was to examine the optical properties of a localized dust cloud created by a nuclear surface burst. The primary objectives are: (1) Model the dust cloud created by the burst. (2) Determine the number and size distribution of particles lofted. (3) Evaluate the extinction efficiency of each of the particles based on radius of the particle and signal wavelength. (4) Compute the optical thickness at any location within the cloud as it settles to the ground. The technique used to calculate these values was based on calculating the extinction coefficient at 100 points along a line-of-sight through the dust cloud. The optical thickness at each point was then computed using the product of pathlength traveled and extinction coefficient at each point. The results of the study demonstrated that the optical thickness generated by smaller, more localized bursts, was much greater than bursts that create global dust clouds. The localized dust cloud was also modeled to simulate global dust clouds of other models. The optical thickness of these dust clouds were within one percent of the optical thickness predicted by other experiments.

47868 (AD-A–207466/4/XAB) **Target acquisition methodology enhancement (TAME). Final report, March 1988-March 1989.** Bauman, W.J. Army Concepts Analysis Agency, Bethesda, MD (USA). Mar 1989. 109p. (CAA-TP–89-122). Available from NTIS, PC A06/MF A01.

The TAME report describes a general approach for assessing target unit acquisition in a tactical nuclear scenario, given well-defined input functions representing acquisition and retention conditioned on environment and elapsing time. Input functions suitable for constructing an operational program to execute the methodology are to be generated in an ongoing CAA effort, Target Acquisition Study IV (TAS IV). The methodology supports the Nuclear Fire Planning and Assessment Model III (NUFAM III) at CAA. The TAME approach assesses the acquisition effectiveness of an array of sensors against a target unit. Search and acquisition retention are presented as alternating renewal processes over time. Primary output measures include the steady-state probability of unit acquisition and the probability distribution of residual duration of acquisition retention as a valid target.

47869 (AD-A-207467/2/XAB) **Updating nuclear effects in theater models. Final report.** Youngreen, M.A. Army Concepts Analysis Agency, Bethesda, MD (USA). Nov 1988. 41p. (CAA-RP-88-1). Available from NTIS, PC A03/MF A01.

Large-scale, low-resolution simulation models frequently group nuclear weapons effects against area targets into a few aggregated state vectors. This can create serious inaccuracies in the treatment of multiple-burst and other time-dependent effects. This paper presents improved techniques for updating nuclear weapon effects against area targets, allowing the analyst to model the processes of delay injury (damage), recovery (repair) over time, and the effects of subsequent nuclear bursts. The approach here is to store the effects in a state vector of coefficients for a piecewise Pareto distribution. Examples illustrating the benefits of this approach are provided. This procedure will be implemented in the US Army Concepts Analysis Agency IWFORCEM theater model, but is applicable to any low-resolution simulation that includes nuclear effects representation.

47870 (CONF-870961–Vol.1, pp. 3-21) **A detailed calculation of the collapse of the Misty Rain extension.** Hollis, D.J. (Maxwell Laboratories, Inc., La Jolla, CA (USA)); Reed, L.L.; Wiehe, J. Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 1.* Order Number DE89008622/JAW. Available from NTIS, PC A21/MF A01.

The mass of iron found in the LOS drift during reentry mining of the MISTY RAIN HLOS test continues to be a topic of interest. Its origin has been debated, and the conclusion is that it is a segment of the extension came to rest nearly 60 m along the LOS drift, some 48 m past the end of the original extension. The mass looks remarkably uniform both externally and in cut cross-section. How did it get so far out and still remain in such identifiable condition? Perhaps an engineering artifact (e.g., a tack weld, a structural support, a change in pipe diameter, etc.) provided enough of a discontinuity, at just the right place, that a portion of the unmelted extension, filled with molten iron, broke loose on ground shock loading. Calculations show that ahead of the ground shock, the LOS pipe is usually expanded and open; anything ahead of the ground shock driven closure has a literally unobstructed path along the pipe. This paper discusses a 2-D hydrodynamics calculation of MISTY RAIN pipe closure wherein particular attention was paid to zoning the portal end of the extension. This region is of interest for two reasons: first, none of the portal end of the extension remains unmelted at the end of the calculation. Second, at least two physical discontinuities in the pipe string occurred there. One was a flange where the end of the extension was fitted to the pipe proper, and a second was a fairly sizeable step-up in pipe diameter. Although results do not provide a definitive explanation of how a piece of the extension got so far up the LOS drift, they are suggestive of a plausible mechanism.

47871 (CONF-870961–Vol.1, pp. 22-77) **Containment analyses for the Mission Ghost cavity event.** Rimer, N. (Maxwell Labs., Inc., La Jolla, CA (USA)); Halda, E.; Lie, K.; Nilson, R. Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 1.* Order Number DE89008622/JAW. Available from NTIS, PC A21/MF A01.

Design analyses are presented here which strongly support the conclusion that the lightly decoupled MISSION GHOST event in a hemispherical cavity is very much like an overburied tamped event. These design analyses include (1) site specific nonlinear, axisymmetric, two-dimensional, finite difference calculations of the event-induced ground motions and dynamic fractures, (2) more traditional event specific calculations of the maximum extent to which a fluid filled hydrofracture could be driven by cavity pressure through the preshot in situ stress fields in the tuff, and (3) general parameter studies of the effects of decoupled cavity radius on ground motions, cavity size and pressure, residual stresses, and dynamic hydrofractures. The two-dimensional, site specific, finite difference calculations made using conservative assumptions show strong compressive residual stress fields in the tuff surrounding the nearly spherical expanded MISSION GHOST cavity with only a slight intrusion of cavity gases contained well within these confining stress fields. The more traditional hydrofracture calculations made using the FAST algorithm which contains realistic descriptions of the fluid behavior in the fracture, show a fracture extent of only a few meters, well within the end of stemming of the emplacement tunnel, even if no compressive residual stress fields were induced by the MISSION GHOST event.

47872 (CONF-870961–Vol.1, pp. 81-89) **Experimental and calculational study of wave/fault interaction.** Fogel, M.B. (SAIC, San Diego, CA (USA)); Kilb, D.L.; Nagy, G.; Florence, A.L. Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 1.* Order Number DE89008622/JAW. Available from NTIS, PC A21/MF A01.

Experiments and calculations are described for investigating the elastoplastic interaction of a spherical wave with a planar lubricated fault. The objective is to aid the capability of the DNA containment codes to predict the influence of nearby faults on containment. Comparisons of predicted and experimental particle velocities and displacements tangential to the fault show that the STAR code used provided a good description of the interaction.

47873 (CONF-870961–Vol.1, pp. 90-100) **Junior Jade events - An investigation of decoupling phenomenology.** Smith, C.W. (Sandia National Labs., Albuquerque, NM (USA)). Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 1.* Order Number DE89008622/JAW. Available from NTIS, PC A21/MF A01.

With five 8-pound high-explosive events, the author has explored aspects of the containment phenomenology of partially decoupled events. Three events drove multiple fractures and showed little cavity growth suggesting that the fracture propagation was part of the dynamic process. Two events were contained; their cavity volumes grew by factors of approximately two and three with the tighter-coupled event showing the larger growth. With the five events one sees a spectrum of results ranging from hydrofrac type fracture propagation through multiple fracture propagation to the fully contained case. For the multiple fracture case a partial residual stress field may control the release of the cavity pressure. Measurements of cavity pressure versus time provide a valuable diagnostic of containment.

47874 (CONF-870961–Vol.1, pp. 101-124) **Recent developments in hydrofracture calculations related to containment.** Rimer, N. (Maxwell Labs., Inc., La Jolla, CA (USA)); Nilson, R.H.; Halda, E.J.; Lie, K. Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 1.* Order Number DE89008622/JAW. Available from NTIS, PC A21/MF A01.

Traditional approaches to the calculation of hydrofractures from a nuclear cavity combine detailed realistic treatments of fluid flow and pressure along the crack with linear elastic quasistatic equilibrium computations which determine crack length and opening displacements along the crack for a given stress distribution in the surrounding rock. Nonlinear ground motion calculations of residual stress fields usually provide the stress distributions for these fracture determinations. These traditional approaches to fracture computation do not consider inelastic deformations of the rock near the cavity and potential interactions of the pressurized crack with the global ground motions. This paper describes a new approach which permits the computation of potential hydrofractures from the cavity during the time of the dynamic ground motions before compressive residual stress fields are developed in the surrounding rock. This new dynamic fracture model allows coupled interactions at every time cycle of one- or two-dimensional stress wave codes between the pressurized crack and the nonlinear ground motions. Thus the nonlinear rock constitutive models influence computations of crack porosities and opening displacements and the pressurized cracks in turn can alter ground motions. With this new approach to

fracture computations, either a single crack (or set of cracks) of known orientation and geometries may be specified or the computer code may be allowed to determine locations and geometry of migrating cracks from calculated stress fields.

47875 (CONF-870961–Vol.1, pp. 125-149) **Similarity analysis of condensing flow in a fluid driven fracture.** Griffiths, S.K. (Sandia National Labs., Livermore, CA (USA)); Nilson, R.H. Sandia National Labs., Albuquerque, NM (USA). 1987. DOE Contract AC04-76DP00789. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 1.* Order Number DE89008622/JAW. Available from NTIS, PC A21/MF A01.

The phenomenology of steam-driven fracture propagation is sufficiently complex that comprehensive numerical models are generally required to simulate the overall process. However, to gain a better understanding of the controlling physics and as a check on the more comprehensive models, it is useful to separately investigate some of the important mechanisms which limit fracture growth, such as: pressure decay of the cavity fluid, seepage losses from the crack into the host material, heat loss to the fracture walls, and condensation of fluid within the crack. The present paper is devoted to this last consideration. This paper is the fourth in a sequence of studies which use similarity transformations to solve fundamental problems of fluid driven fracture propagation. The first paper addressed isothermal flow of an ideal gas. The second included heat transfer to the fracture walls, but was still restricted to ideal gases. The third dealt with two-phase gas/liquid flows under isothermal conditions. Here the authors investigate the more general and more realistic case of multiphase, multicomponent flows in which the rate of condensation and re-evaporation is controlled by convective and/or conductive heat transfer to the fracture walls.

47876 (CONF-870961–Vol.1, pp. 150-178) **Simultaneous modeling of dynamic ground motion and fluid flow in hydrofractures.** Nilson, R. (Maxwell Labs., Inc., La Jolla, CA (USA)); Rimer, N.; Halda, E. Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 1.* Order Number DE89008622/JAW. Available from NTIS, PC A21/MF A01.

There are two primary mechanisms which constrain the growth of hydrofractures. First, the outward expansion of the cavity induces compressive hoop stresses which help to clamp the fractures closed. This mechanism is primarily a consequence of the solid mechanics and it is the dominant fracture constraint in well coupled events. Secondly, the extent of gas driven fractures is limited because the cavity contains a finite amount of mass and energy which is continually depleted as the volume and surface area of the fracture grows and the seepage losses and heat transfer to the surrounding rock become progressively greater. These dissipative mechanisms are fluid/thermal in origin, and they are the dominant fracture constraints in decoupled events. Ground motion analyses have ignored the presence of gas-driven fractures except in the very recent work reported by Rimer et al at this symposium. Conversely, traditional fluid/thermal analyses of hydrofracture have been based upon preshot or postshot stress fields or, at best, the time-dependent stress field calculated to exist in the absence of fractures. The present hydrofracture analysis includes both the solid-dynamic and the fluid/thermal processes in a single fully-interactive model. The FAST hydrofracture algorithm calculates the pressure distribution along the crack and the rate of advance of the fluid. The CRAM ground motion code calculates the aperture distribution along the crack and the rate of advance of the crack tip. This combined model, called F-CUBED (Fast Fluid Fracture) is used to investigate fracture propagation from explosive events ranging from strongly to weakly coupled, with emphasis placed on the intermediate regime in which both fluid/thermal and solid-dynamic aspects are important.

47877 (CONF-870961–Vol.1, pp. 181-195) **Preliminary surface ground motion calculations with the SHALE code.** DeVault, G.P. (Los Alamos National Lab., NM (USA)). Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 1.* Order Number DE89008622/JAW. Available from NTIS, PC A21/MF A01.

SHALE is a 2-D finite-difference ALE code for calculations of the propagation of stress waves in solids. One of its intended applications is that of simulating underground nuclear weapons tests. SHALE uses a microphysical constitutive model to treat the possible simultaneous crushing of pores and occurrence of fracture by crack propagation. At the time of these calculations, the fracture theory was not sufficient to give the proper cavity radii and an elastic-plastic model had to be used. However, the surface ground motion and associated spall were represented quite well by the fracture model. This paper discusses the first complete SHALE calculations of surface ground motion for two separate events. The first is SALMON, an event in which the material medium is modeled as homogeneous salt. The second is SANDREEF, an event in inhomogeneous material modeled by four horizontal layers ranging from water saturated tuff to alluvium. A model was developed that contributed to the pulse dispersion in the alluvium. The results are compared with measurement.

47878 (CONF-870961–Vol.1, pp. 196-234) **Geologic and material property combinations that adversely influence residual stress in 2-D dynamic containment calculations.** Rambo, J.T. Sandia National Labs., Albuquerque, NM (USA). 1987. DOE Contract W-7405-ENG-48. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 1.* Order Number DE89008622/JAW. Available from NTIS, PC A21/MF A01.

There is a developing history of 2-D TENSOR calculational studies of various geological sites and configurations. Calculations are usually very site specific, with a variety of complications and sensitivities to material properties. However, similar influential material properties occur in many of the calculations. Examples of these properties are porous interfaces, hard rock layers, and nearby Paleozoic scarps. It is useful to be aware of the degrading effects that these properties may have on the residual stress field so that future underground nuclear test site calculations will include the appropriate geological and material models. A brief summary is given of calculations to date with geologic/material combinations that reduce residual stress or increase cavity pressure.

47879 (CONF-870961–Vol.1, pp. 235-249) **Effects of late time creep and cavity depressurization on the residual stress field.** Fogel, M.B.; Ranta, D.E. Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 1.* Order Number DE89008622/JAW. Available from NTIS, PC A21/MF A01.

Two late time containment concerns are examined in this paper. The first is the effect of creep on the residual stress field, and the second is the effect of cavity depressurization on both the residual stress field and the potential for chimney formation. A quasi-static two dimensional finite element code, GRIFFIN, consistent with the Lagrangian codes used to perform the ground motion calculations, was used to address these issues. To examine the effects of creep, a viscoelastic model known as the standard linear solid was used to represent the creep behavior of a typical tunnel bed tuff. The late time results of a dynamic calculation of a nuclear shot in this material were overlayed into GRIFFIN, and, within the quasi-static approximation, the stress field was adjusted to accommodate the viscoelastic softening of the material. The results of these calculations and their sensitivity to model parameters are presented. The effect of cavity depressurization on the residual stress field is also examined in this paper. The results of a finite difference calculation of a nuclear shot in a representative tuff was used to initialize GRIFFIN. The cavity pressure was then reduced, and the equilibrium stress field, including the effects of gravity, was found.

47880 (CONF-870961–Vol.1, pp. 253-296) **Multi-component stress history measurements and analysis.** Stout, R.B.; Larson, D.B. Sandia National Labs., Albuquerque, NM (USA). 1987. DOE Contract W-7405-ENG-48. From 4. symposium on containment of

underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 1.* Order Number DE89008622/JAW. Available from NTIS, PC A21/MF A01.

Piezoresistance foil gages were tested dynamically in multi-component stress-strain experiments in order that the actual shock wave conditions of underground nuclear testing could be more closely simulated. The multi-component stress-strain histories were created in polymethylmethacrylate (PMMA) by using chemical explosions to generate spherical shock waves. In addition to the resistivity measurements from the foil gages, particle velocity was also measured at several radial positions from the explosion to provide a complete set of data for analysis. The gage interpretation (inverse) problem for multi-component stress-strain fields requires obtaining a sufficient number of independent measurements so that the different stress-strain components influencing the gage response can be uniquely inferred. The piezoresistance measurements provided data from a triple material foil gage and from ytterbium foil gages (bare gages). An analysis shows that the triple material gage containing foils of ytterbium, manganin, and constantan provided three independent resistivity measurements for the gage oriented in a perpendicular direction relative to the radial propagating shock front. An analysis of the ytterbium foil gages, which were tested in both perpendicular (normal) and parallel (tangential) directions relative to the radial shock front, show the resistivity responses from these two orientations are independent measurements. The results from the analyses of the gages compared well with experimental data. This analysis shows clearly that the material properties of the foil, the dimensions of the foil, and the material surrounding the foil greatly influence the total resistivity response of foil gages in a multi-component stress-strain field.

47881 (CONF-870961–Vol.1, pp. 297-317) **Theoretical and experimental analyses of in-situ gauge inclusion effects.** Swan, C.C. Jr.; Smith, C.W. Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 1.* Order Number DE89008622/JAW. Available from NTIS, PC A21/MF A01.

A wide-ranging study of gauge inclusion effects within the stress regime of 10 to 100 MPa is performed. These analyses pertain to three fieldings of radial stress gauges during the high explosive HALFTON test. First, axially loaded cylindrical inclusions representative of the toadstool gauge emplacement are modelled. Subsequently, the responses of two paddle gauge inclusion geometries, side-loaded cylinders and normally loaded slots, are studied under both quasi-static and HALFTON loading environments. Calculational analysis and scrutiny of the gauge measurement records are used to quantify possible inclusion effects within the stress measurement records. Accordingly, recommendations are made on optimal gauge fielding techniques.

47882 (CONF-870961–Vol.1, pp. 318-341) **Stress measurements with the sea Calip gauge.** Keller, C. (Science and Engineering Associates, Inc., Santa Fe, NM (USA)); Smith, P.; Zigler, G.; Dunn, S.D. Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 1.* Order Number DE89008622/JAW. Available from NTIS, PC A21/MF A01.

Science and Engineering Associates, Inc., has designed a stress gauge called the CALIP gauge, which can be recalibrated in place in a grouted bore hole before, and after, the measurement of the shock wave stress history. This gauge is an extension of the Stanford Research Institute gauge called a flatpack. The CALIP gauge allows an accurate measurement of the dynamic stress history, the post shock-wave residual stress and the gauge system baseline shift. This capability is demonstrated at the 1Kbar level near a 1000 lb. HE buried explosion. A digital recording system has been developed for immediate analysis of the calibration results during the calibration procedure.

47883 (CONF-870961–Vol.1, pp. 342-360) **The effect of pore fluid diffusion in grout spheres.** Peterka, D.; Duff, R. Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 1.* Order Number DE89008622/JAW. Available from NTIS, PC A21/MF A01.

The effect of pore fluid diffusion on the relaxation of the residual stress field in grout sphere geometries was investigated using the DYNAFLOW finite element code. The DYNAFLOW code couples elasto-plastic material deformation with pore fluid diffusion using Biot's effective stress theory. Results are compared against laboratory results obtained by SRI International. It was found that the magnitude of stress relaxation of the residual stress field in grout spheres could not match the SRI results without presuming significant deterioration of rock strength. The resulting rock strength could not support the formation of the residual stress, however. Reasonable grout strengths allowed peak stress reductions of at most 30%. Diffusion time scales could be matched by presuming an order of magnitude increase in grout permeability.

47884 (CONF-870961–Vol.1, pp. 361-366) **Stemming column phenomenology.** Smith, C.W. (Sandia National Labs., Albuquerque, NM (USA)). Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 1.* Order Number DE89008622/JAW. Available from NTIS, PC A21/MF A01.

Cliff Olsen of Lawrence Livermore National Laboratory (LLNL) has reported measurements of unusual stress-time behavior in the stemming column of a nuclear event. Following the dynamic stress peak, he sees a second stress peak whose amplitude sometimes exceeds the dynamic pulse. The author has seen a similar phenomena in grouted drill holes which stem 64-lb high explosive events. Although he has not explained the phenomena, he offers the following hypothesis. The stemming material responds differently than the host material to the unloading and rebound dynamics that occur with the formation of the residual stress field. He challenges the calculation community to model and predict this phenomena, for understanding it may lead to potentially useful stemming techniques.

47885 (CONF-870961–Vol.1, pp. 369-377) **Post-failure strength of gypsum silica-sand aggregate stemming material.** Kusubov, A.S. (Lawrence Livermore National Lab., CA (USA)); Anderson, G.D.; Dockery, H.A. Sandia National Labs., Albuquerque, NM (USA). 1987. DOE Contract W-7405-ENG-48. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 1.* Order Number DE89008622/JAW. Available from NTIS, PC A21/MF A01.

Post-failure stress-strain tests were performed on a mixture of gypsum cement and silica-sand aggregate used as stemming material for emplacement holes in underground nuclear testing. The purpose of these tests was to evaluate the remaining strength of the stemming material after it underwent initial failure at confining pressures typical of those found near the working point of the explosion. The failure data can also provide constitutive parameters that can be incorporated into future numerical calculations of the residual stress field of the stemming material. Individual samples were loaded to failure at a single elevated confining pressure. The experiments spanned a range of confining pressures from 10 to 300 MPa. For a set of samples experiencing failure at a given confining pressure, each sample was subjected to a different amount of strain (up to 15%) subsequent to failure. After this procedure, each sample of failed material was then reloaded to failure again, but without confining pressure. The results indicate that the unconfined post-failure compressive strength of the material decreases as a function of increasing initial post-failure strain under confining pressure. Also, the samples that have experienced more than 15% initial post-failure strain under confining pressure have a complete loss of strength upon reloading without confining pressure.

47886 (CONF-870961–Vol.1, pp. 378-401) **Recent material test data and material response models for damage in tuff and**

grouts. Patch, D.F.; Fogel, M.B.; Klauber, W.; Lupo, J. Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 1.* Order Number DE89008622/JAW. Available from NTIS, PC A21/MF A01.

For the past several years, strength degradation in test media following shock passage has been modeled in earth motion calculations for underground nuclear events fired in Area 12 at the Nevada Test Site. The need for such models first was suggested by pre- and postshot DINING CAR material response data. Particle velocity data obtained subsequently in HE tests fired in G-Tunnel and in small scale laboratory HE tests showed the influence of damage on the late-time earth motion. To quantify this behavior for use in constructing calculational models, a number of quasi-static material response tests were conducted along relatively uncommon stress-strain paths using tuff cored near the working points of several recent events in N- and T-Tunnel. While most cores were obtained preshot, limited data exist for postshot samples recovered from high stress-strain regions. These data are reviewed and material response models based on them for the MISTY RAIN and MIGHTY OAK events are outlined. Uncertainties in the data and material models are discussed. Because stemming materials must form a competent plug that isolates the cavity from the unstemmed portion of the tunnel complex, the dynamic and late-time behavior of these grouts in response to ground shock loads is critical to the containment of horizontal line-of-sight events. The deviatoric response of these materials is compared to that observed for tuff. Strong dependence on the stress-strain history and lessor strain-rate and drainage effects, are seen in these media. Only some aspects of the observed material behavior are captured in current material response models. Suggested future material test needs and model improvements are described.

47887 (CONF-870961–Vol.1, pp. 402-451) **Predicting the response of shock-conditioned tuff from Rainier Mesa using laboratory tests.** Lupo, J.F. (Terra Tek, Inc., Salt Lake City, UT (USA)); Klauber, W.; Green, S.J.; Lacomb, J.W. Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 1.* Order Number DE89008622/JAW. Available from NTIS, PC A21/MF A01.

Terra Tek has been studying the behavior of post-event (shock conditioned) tuff since the mid-1970's. The data presented in this paper are derived from several recent laboratory studies on post-event tuff. When combined with observations from earlier laboratory studies, this data is useful in drawing conclusions about the response of damaged tuff. The results of extensive cycled laboratory tests in an attempt to simulate the shock conditioning of tuff are also used in development of an approximate method to predict the stress-stress response of shock-conditioned Rainier Mesa tuff. Section 2 summarizes the database of observations made on post-event tuff. Section 3 discusses the laboratory efforts to simulate post-event tuff. Comparisons of laboratory observations on event-damaged versus laboratory-damaged tuffs are made in Section 4, and a summary is presented in Section 5. All of the presented data is plotted against peak stress as seen in the field.

47888 (CONF-870961–Vol.1, pp. 452-479) **The effect of strain paths calculated for spherically symmetric explosions on measured damage in tuff.** Rimer, N. (Maxwell Labs., Inc., La Jolla, CA (USA)); Green, S.; Klauber, W. Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 1.* Order Number DE89008622/JAW. Available from NTIS, PC A21/MF A01.

Core samples of tuff taken from inside of 2-4 Kb peak stress levels from nuclear events, when subjected to laboratory uniaxial strain loading tests, show much lower stress differences (strengths) than reported for virgin samples of similar tuff, even at high confining pressures (2-4 Kb). Implied failure surfaces from cycled uniaxial strain load-biaxial (constant axial strain) unload tests followed by triaxial compression, are similar to the shot damaged results at low confining pressures but do not show the large strength reduction at high confining pressures seen for the shot damaged tuff. Strain paths calculated for spherically symmetric explosions in tuff are presented here which indicate that the biaxial strain unload path, although clearly a better approximation to in situ strain paths than was a uniaxial strain unload, restricts the amount of shear strain experienced by the tuff on unload. These calculated strain paths provided the basis for new and different material properties tests which were conducted to verify the hypothesis that increases shear strain levels were responsible for the enhanced damage measured from postshot cores.

47889 (CONF-870961–Vol.1, pp. 480-493) **Shock vaporization and melting of saturated tuff.** Higgins, G.H. (Fenix and Scisson, Inc., Woodland, CA (USA)). Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 1.* Order Number DE89008622/JAW. Available from NTIS, PC A21/MF A01.

The initial shock wave generated in the wall of the chamber containing a nuclear explosion is far in excess of that needed to vaporize the rock. As the shock wave passes outward it decays to pressures which successively vaporize, then melt, and finally only heat the rock before decaying to a seismic wave. The phase changes, which include vaporization, melting, and decomposition, go on during expansion after peak pressure has passed. In this paper vaporization and melting of tuff typical of T Tunnel is estimated. Complete vaporization was found from shocks above 1150 kb (115 GPa), and vaporization started at 550 kb. Water in pores was shocked into the super-critical region by shocks above 200 kb. Extreme convection resulting from large density and velocity differences and by radiation flow equalizes the cavity temperature. Initially the cavity gas is slightly over half steam, but within a second all rock vapor has condensed, while steam from the molten and nearly molten rock has entered the cavity in amounts appropriate to energy conservation and the equilibrium solubility of water in glass. The cavity is filled with 220 ton/KT of steam at about 1400°C. This creates a pressure of about 82 bars (8.2 MPa) which may be greater than the residual stress called the containment cage. Lower pressures and easier containment can be found at sites which have lower water content. More studies of cavity glass are needed.

47890 (CONF-870961–Vol.2, pp. 3-17) **Idealized proximity response of the DBS.** Fenster, R.A. (Los Alamos National Lab., NM (USA)). Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 2.* Order Number DE89009077/JAW. Available from NTIS, PC A21/MF A01.

The gamma-gamma density tool (DBS) used in containment borehole logging at the Nevada Test Site has two proximity indicators, devices intended to measure the gap between the density pad and borehole wall. These proximity indicators are located at each end of the density pad. The response of the proximity indicators is presented used to determine a correction factor for the basic (raw) density data. Proper interpretation of proximity log data is essential if valid corrections are to be made. The use of idealized response curves has long been a key to the interpretation of logging instruments and this technique will be used here to show the relationship of proximity data to density data. Proximity data, as presented on the density log, should not be used directly to correct the basic density values. An alternate density corrections techniques is presented. The response of a single proximity indicator, similar to that used in the single detector gamma-gamma density tool but centered between the source and detector, is also examined.

47891 (CONF-870961–Vol.2, pp. 18-26) **Borehole inspection system for large diameter holes.** Hawkins, W.L. (Los Alamos National Lab., NM (USA)); Oliver, R.D.; Lavelle, M.J. Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 2.* Order Number DE89009077/JAW. Available from NTIS, PC A21/MF A01.

A color camera developed for underwater applications has been adapted for use as a large diameter Borehole Inspection System (BIS). This video/photographic system has pan and tilt capabilities and remotely interchangeable lenses. A compass provides an azimuth for orientation. It is designed to operate in boreholes ranging in diameter from 1.2 m to 3.0 m. The system has a 180 degree fisheye lens and an inspection lens with zoom. 35 mm photographs can be taken of the same view as the video for precise location. Video tape and 35 mm film is annotated. The primary function of the BIS is geologic investigation. Various characteristics of the geologic medium can be viewed. Lithologic types and textures can be determined. Structural features such as faults, fractures, and bedding can be scrutinized. Detail descriptions of stratigraphic sequences and contacts are possible. In combination with other borehole data and sample information, many questions about hole conditions and the geologic medium can be resolved. Field operations often demand immediate resolution of borehole problems. This system offers on-the-spot visual inspection of the drill hole and associated hardware. Large eroded zones can be evaluated and casings and liners can be inspected. Other applications such as the location and configuration of hardware left in the hole and fluid entry points are possible.

47892 (CONF-870961–Vol.2, pp. 27-55) **Definition of stratigraphic units between the Grouse Canyon and Rainier Mesa tuffs in Los Alamos-use areas of Yucca Flat, Nevada Test Site.** Drellack, S.L. Jr. (Fenix and Scisson, Inc., Mercury, NV (USA)); Warren, R.G.; Hughes, W.T. Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 2.* Order Number DE89009077/JAW. Available from NTIS, PC A21/MF A01.

Preliminary petrochemical work allows the authors to relate bedded tuffs between the 14.1-Ma Grouse Canyon (Tbg) and 11.6-Ma Rainier Mesa (Tmr) Tuffs in the subsurface of Yucca Flat to ash-flow tuffs and lavas that occur elsewhere within the region of the Nevada Test Site (NTS). Within this stratigraphic interval in Yucca Flat, they find tuff from four formations defined within the region: the Crater Flat, Wahmonie, Area 20, and Paintbrush, in ascending order. They recognize an additional unit immediately beneath Tmr that correlates with the Transition tuff petrologic zone recently defined in subsurface of Pahute Mesa. The authors recommend routine subdivision of post-Tbg, pre-Tmr tuffs into individual units rather than assignment to the Paintbrush Tuff for several reasons. First, Paintbrush Tuffs are formally defined by a scarcity or absence of quartz phenocrysts, and the prominence of quartz phenocrysts within specific post-Tbg, pre-Tmr stratigraphic horizons is inconsistent with this definition. These quartz-bearing intervals are correlative with Area 20 and Crater Flat Tuffs. Second, the stratigraphic equivalence of the mafic-rich zone of the paintbrush and the pre-Paintbrush age Wahmonie Formation has been firmly established by recent work. Third, the Tiva canyon, Topopah Spring, and Stockade Wash ash flows are intercalated within the post-Tbg, pre-Tmr sequence of bedded tuffs in extreme southeastern Yucca Flat, complicating correlations within the present stratigraphic system. Finally, post-Tbg, pre-Tmr tuffs record more than half of the time interval for deposition of important volcanic units in Yucca Flat. Thus, early structural development of Yucca Flat can be better understood if they utilize stratigraphic units within the post-Tbg, pre-Tmr sequence that represent well-defined, narrow time intervals.

47893 (CONF-870961–Vol.2, pp. 56-74) **Pre- and post-event elevation and horizontal surveys across the Yucca and Topgallant faults, Nevada Test Site.** Krier, D. (Los Alamos National Lab., NM (USA)); App, F.N.; Medina, L. Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 2.* Order Number DE89009077/JAW. Available from NTIS, PC A21/MF A01.

Three survey lines each were run across surface expressions of the Yucca and Topgallant faults in conjunction with the two nearby underground nuclear tests KINIBITO and GLENCOE. Survey data included both pre- and post-event elevations and horizontal displacements. Post-event, the faults are marked by an abrupt elevation loss of 24 to 48 cm superimposed on a background of general subsidence caused by spall compaction. The elevation loss recovers quickly to background spall compaction values over only short distances away from the surface trace. Both faults have slight elevation gains of their western (upthrown) block. Horizontal displacements were less indicative of fault movement, but the faults are marked by changes in azimuth of displacement. A net north to northeast movement of the survey area around KINIBITO and a net southward movement of the area around GLENCOE is recorded in the data. Several centimeters of right lateral motion may be indicated for the Topgallant fault; the Yucca fault data is more ambiguous. The elevation data show that relative block motion played only a minor role in the losses recorded across both faults. The similar magnitudes of elevation loss across the faults indicate that differential compaction of the thicker alluvial sections on the downthrown blocks was not a measurable result from either of these events. The rapid recovery of elevation to background values near the fault trace suggests that shock compaction is crushing the weaker alluvium adjacent to the tuff beds at depth where the units are juxtaposed by fault geometry. This decrease in pore space could result in the enhanced subsidence along the surface trace of the faults that is observed consistently in the surveys.

47894 (CONF-870961–Vol.2, pp. 77-88) **Applications of vertical seismic profiling at NTS.** Burkhard, N.R. (Lawrence Livermore National Lab., CA (USA)). Sandia National Labs., Albuquerque, NM (USA). 1987. DOE Contract W-7405-ENG-48. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 2.* Order Number DE89009077/JAW. Available from NTIS, PC A21/MF A01.

Vertical Seismic Profiling (VSP) data can be used to refine the geologic interpretation of the structural setting around an emplacement hole at NTS. Traditionally, VSP data have been used as a tool to assist in the interpretation of surface seismic Common Depth Point (CDP) reflection data. LLNL has been examining several direct applications to the geologic characterization of an emplacement site. VSP data from a single surface seismic source location near an emplacement hole can be used to determine the depth and apparent dip of reflecting horizons below the bottom of the hole. With multiple surface seismic source locations, the true dip of a reflector can be determined. In some cases, the evidence of the presence or absence of the reflector is all that is required for containment evaluation. An example of this technique (along with its shortcomings) using data from hole, U20ar is presented. Offset VSP data are obtained when the surface source is not near the well head. This technique uses the direct and reflected energy and differs from half-refraction techniques that utilize only the refracted head waves. A convenient method of imaging these data involves the transformation of these data from the traditional VSP domain to a CDP domain. In the CDP domain, the transformed VSP data resemble a CDP reflection section. Standard surface seismic reflection techniques can be utilized to determine the structure on a portion of the plane defined by the emplacement hole and the surface seismic source location. Data from experimental deployments of this technique at hole, U4ag are presented.

47895 (CONF-870961–Vol.2, pp. 135-154) **Possible relation between sonic velocity measured at the edge of a large borehole and shear failure.** Rambo, J.T. (Lawrence Livermore National Lab., CA (USA)); Swift, R.P. Sandia National Labs., Albuquerque, NM (USA). 1987. DOE Contract W-7405-ENG-48. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 2.* Order Number DE89009077/JAW. Available from NTIS, PC A21/MF A01.

Velocities of P-waves measured next to the walls of large-diameter boreholes with the dry-hole acoustic logger are typically lower than velocities across similar geologic media measured farther from the borehole wall using other techniques (Vibroseis). The difference in velocity is attributed to a weakened zone around the borehole wall, which in part may be due to disturbance from drilling

and, in part, to the relief of overburden stresses in the vicinity of the borehole wall. P-wave velocity measurements in alluvium and tuffs show high sensitivities to confining pressures in the range of overburden stresses for many Nevada Test Site holes. When isotropic strength is assumed, elastic-plastic pressure-dependent strength models suggest that lower velocities should occur next to the borehole wall and that shear failure of the medium is necessary to reduce the mean stress and the P-wave velocity. The borehole walls of many holes appear to have failed sufficiently to relieve overburden stresses in major portions of large-diameter Nevada Test Site (NTS) holes. There are documented cases of radioactive gas proceeding past plug locations. On the basis of this analysis, it is prudent to consider the possibility that the damaged wall of the hole is a pathway. An analysis of the RIOLA and ROQUEFORT Events indicates that radioactivity could have bypassed the plug locations because of a weak annulus. The authors recommend that, where exact plug locations are not dominated by other factors, plugs be placed in regions where minimal annulus damage has occurred.

47896 (CONF-870961–Vol.2, pp. 155-163) **Relationship between large-hole drilling rates and compressive strength of NTS rock types.** Anderson, G.D. (Univ. of California, Livermore (USA)); Rambo, J.T.; Kusubov, A.S.; Dockery, H.A.; McKinnis, W.B. Sandia National Labs., Albuquerque, NM (USA). 1987. DOE Contract W-7405-ENG-48. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 2.* Order Number DE89009077/JAW. Available from NTIS, PC A21/MF A01.

Calculations to simulate and evaluate nuclear test containment require data on the strength of the geologic media at the work point and in the surrounding region. Studies cited in the literature reveal correlations between mechanical properties of rocks and various drilling parameters of large horizontal boring machines that share similarities with drilling assemblies used at the Nevada Test Site (NTS). An extensive selection of downhole core samples spanning the strength range of NTS rocks has been collected, stratigraphically and petrologically identified, and tested for strength as a function of confining pressure. Detailed data on the drilling rates are available for similar geologic units identified in the compilation and also for the specific rocks from these vertical holes that were tested. These data are used to discuss a preliminary empirical correlation between reported laboratory-measured compressive strength and drilling rates for various NTS rock types.

47897 (CONF-870961–Vol.2, pp. 164-200) **Measurement of in situ strength using projectile penetration: Tests of a new launching system.** Hearst, J.R. (Lawrence Livermore National Lab., CA (USA)); Newmark, R.L.; Charest, J.A.; Lynch, C.S. Sandia National Labs., Albuquerque, NM (USA). 1987. DOE Contract W-7405-ENG-48. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 2.* Order Number DE89009077/JAW. Available from NTIS, PC A21/MF A01.

LLNL (Lawrence Livermore National Laboratory) has a continuing need to measure rock strength in situ, both for simple prediction of cavity size, and as input to computational models. In a previous report the authors compared two methods for measuring formation strength in situ: projectile penetration and a cone penetrometer. They determined that the projectile method was more promising for application to the large-diameter (2-4-m) hole environment. A major practical problem has been the development of a launcher and an apparatus for measuring depth of penetration that would be suitable for use in large-diameter holes. They are developing a gas-gun launcher system that will be capable of measuring both depth of penetration and deceleration of a reusable projectile. The current version of the launcher is trailer-mounted for testing at the Nevada Test Site (NTS) in tunnels and outcrops, but its design is such that it can be readily adapted for emplacement hole use. The authors tested the current launcher on 60-cm cubes of gypsum cement, mixed to provide a range of densities (1.64 to 2.0 g/cc) and strengths (3 to 17 MPa). They compared depth of penetration of a 84-g projectile from a Betsy seismic gun - traveling on the order of 500 m/s - with the depth of penetration of a 13-kg projectile from the gas gun - traveling on the order of 30 m/s. For projectiles with the same nose size and shape, impacting targets of approximately constant strength, penetration depth was proportional to projectile kinetic energy. Tests in tuffs with a wide range of strengths at NTS gave a similar linear relationship between the ratio of kinetic energy to penetration and target strength, and also a linear relationship between deceleration and strength.

47898 (CONF-870961–Vol.2, pp. 201-225) **Spectral reflectance characteristics of clay-bearing soils: Applications to downhole environments.** Gradie, J.C. (Univ. of Hawaii, Honolulu (USA)); Roush, T.L. Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 2.* Order Number DE89009077/JAW. Available from NTIS, PC A21/MF A01.

Visible and near-infrared spectral reflectance properties from 0.4 to 4.7 μm were used to characterize the mineralogy and chemistry of 23 soil samples from the Nevada Test Site. These samples represent primary materials, materials resulting from a range of primary and secondary alteration, alluvium, and tuff. The bi-directional reflectance spectra, measured with the Planetary Geosciences spectrogoniometer facility, show that the spectra of all altered materials exhibit absorptions. The presence of calcite can be identified in the spectra when it occurs in concentrations greater than 1 volume percent. In general, calcite absorption band depths correlate with the volume abundance of calcite present in a sample. Hydroxyl-bearing minerals are detected by absorption bands at 2.2-2.3 μm (Al cation) and 2.3-2.4 μm (Mg cation). The presence of zeolite in these samples appears to be correlated with the shape of the combination and/or overtone absorptions of water fundamentals at 1.4 μm, 1.9 μm and 3 μm. Spectra of all samples show a wide range of oxidation and, in addition, a range in the degree of crystallinity of the ferric-bearing materials. In conclusion, reflectance spectroscopy can provide a variety of information concerning the chemistry and mineralogy of these soil samples. However, before in situ measurements are employed, the effects on the spectral reflectance of the hydration and dehydration of these samples must be characterized.

47899 (CONF-870961–Vol.2, pp. 229-236) **Fluid dynamics of a pressure measuring system for underground explosive tests.** Dykhuizen, R.C. (Sandia National Labs., Albuquerque, NM (USA)); Smith, C.W. Sandia National Labs., Albuquerque, NM (USA). 1987. DOE Contract AC04-76DP00789. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 2.* Order Number DE89009077/JAW. Available from NTIS, PC A21/MF A01.

Numerical and analytical models are used to optimize a pressure measuring system for underground nuclear tests. This system uses a long pipe filled with gas to communicate the pressure level to a transducer in a pressure chamber remote from the explosion. During the explosion, the high pressure gas blows down, preventing debris from entering and clogging the system. The models were first checked against the Junior Jade test series, which used an underground non-nuclear explosion to simulate a nuclear test. It was found that the measured pressure oscillated for some time before settling down to a steady value. This is shown to be a result of an organ pipe oscillation that can develop in the short pipes used for this test series. The analytical model provided a simple means to optimize the system design parameters and showed that changing the working fluid from nitrogen to helium would improve the time response of the system significantly. The numerical model is then used to obtain more accurate predictions of the system response.

47900 (CONF-870961–Vol.2, pp. 237-265) **CORNUCOPIA cavity pressure measurement.** Hudson, B. (Lawrence Livermore National Lab., CA (USA)); Cordill, C.; Starrh, L.; Kalinowski, J.; Stubbs, T.; Keller, C.; Peterson, E.; Nilson, R. Sandia National Labs., Albuquerque, NM (USA). 1987. DOE Contract W-7405-ENG-48. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 2.* Order Number DE89009077/JAW. Available from NTIS, PC A21/MF A01.

A cavity-pressure measurement experiment was fielded on the CORNUCOPIA event. Electrical cables extended from a recording facility to an experiment package located deep in the emplacement hole, but not so deep as to be subjected to damaging stress levels from the outgoing shock wave. The experiment package contained high-pressure tanks, valves, and pressure transducers. A set of three stainless-steel tubes extended from the experimental package to the detonation elevation. These tubes were wound in the form of a helix with a pitch chosen such that as the cavity grew and the surrounding medium was displaced, axial compression and tension along the axis of each tube would balance. A few seconds before detonation, explosively driven valves were opened, pressurizing the water-filled tubes. Shortly after detonation, the strong shock wave vaporized and/or melted the end of each tube, allowing the pressurized water to be blown out. The experiment performed very well, giving a complete pressure history for each of three independent sets of tube, transducer, and recording channels, from a few seconds before detonation until cavity collapse, approximately nine hours later. Agreement between the three individual data channels was extremely good, showing a minus-time pressure from 10,700 to 11,400 psia, followed by a steep drop to a level of about 1500 psia at 10 s. After 1 min, the pressure underwent minor oscillations as it fell to about 160 psia at 2 1/2 h. From this time on, the pressure decreased monotomically, reaching about 100 psia approximately 35 min before collapse. The pressure then decreased at a much steeper rate until collapse, after which the record terminates as a result of electrical cable damage.

47901 (CONF-870961–Vol.2, pp. 266-275) **Chemical considerations and containment.** Duff, R.E. (Maxwell Labs., Inc., La Jolla, CA (USA)). Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 2.* Order Number DE89009077/JAW. Available from NTIS, PC A21/MF A01.

Chemical reactions in a nuclear explosion cavity have long been recognized as a potential source of the noncondensible gases CO_2 and H_2 which might constitute a late-time threat to containment. The source of CO_2 is carbonate rock decomposition, and H_2 comes from oxidation-reduction reactions involving Fe or Al and water. Calculational results are presented which show how equilibrium H_2 concentration changes with temperature under a variety of conditions. The potential advantage of oxidizing agents near the WP will be shown, but experimental results obtained when MnO_2 was used as a stemming material did not demonstrate improved containment. Another region where the oxidation-reduction reaction could be important is the stemming column of DNA HLOS experiments. The oxidation of LOS fragments by water in the grout may produce H_2 which generates late time pressure on the closures, sweeps radioactive gas into the tunnel complex, and provides the fuel for the fires and explosions seen recently. A laboratory experiment is described which qualitatively demonstrated that this reaction proceeds rapidly at temperatures under 250°C, and it produces pressures greater than 1400 psi (9.7 MPa). This experiment also demonstrated that adding MnO_2 to the stemming suppressed the H_2 generation.

47902 (CONF-870961–Vol.2, pp. 276-282) **Reaction kinetics and hydrogen generation.** Gaffney, E.S. (Ktech Corp., Albuquerque, NM (USA)). Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 2.* Order Number DE89009077/JAW. Available from NTIS, PC A21/MF A01.

Kinetics of reactions between cavity gases and steel, iron oxides and iron silicates will limit the rate at which chemical equilibrium is approached in the production of noncondensible gas by underground nuclear tests. A preliminary estimate based on only a few published data for steel-steam reactions indicates that reaction rates will be very low at temperatures below about 1000 to 1200 K. The physical state of the metal, oxides and silicates, especially the specific surface, also has an important effect on the reaction rates.

47903 (CONF-870961–Vol.2, pp. 285-287) **Breathing on the Mesa.** Woodward, E.C. Jr. (Lawrence Livermore National Lab., CA (USA)). Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 2.* Order Number DE89009077/JAW. Available from NTIS, PC A21/MF A01.

Subsequent to the execution of several events on Pahute Mesa noble gas samplers have detected radioactive noble gas. This has been attributed to atmospheric pressure cycling (breathing) assisting diffusion in enabling gaseous radioactive fission debris to reach the surface. The geology of an event site, in particular the depth of the Rainier Mesa Member of the Timber Mountain Tuff, may well play a role in the amount and timing of this phenomenon. The author sought to determine whether there might be a feature of the event site which might explain the phenomenon and possibly predict its future occurrence.

47904 (CONF-870961–Vol.2, pp. 288-315) **Estimation of the bulk diffusivity of chimneys using post-shot holes.** Burkhard, N.R. (Lawrence Livermore National Lab., CA (USA)); Hearst, J.R.; Hanson, J.M. Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 2.* Order Number DE89009077/JAW. Available from NTIS, PC A21/MF A01.

LLNL has been calculating the bulk diffusivity of chimney regions using measurements of atmospheric pressure variations. Fluctuations in atmospheric surface pressure and subsurface pressure (measured in a post-shot hole of opportunity) are compared to determine the diffusivity. The diffusivities calculated to date range from about 130 to 31,000 m^2/hr. Time and frequency domain techniques have been utilized to determine this range of diffusivity. Some limitations of this method of diffusivity determination have been discovered. Useful data have been obtained in the frequency band 0.002-0.03 cycles/hour. The effect of the water table upon their measurements has been determined. The theoretical impulse response functions for a typical geologic setting can be quite long (> 300 hours). Therefore, the surface pressure history for time spans greater than this or the entire initial pressure distribution ($p(z,t = 0)$) in the geologic setting must be known before gas transport predictions from transport models can be reliably made, as the driving pressures for transport depend upon these initial conditions.

47905 (CONF-870961–Vol.2, pp. 316-339) **Fickian filtering of cavity gases rising through a fractured permeable overburden.** Nilson, R.H. (Maxwell Labs., Inc., La Jolla, CA (USA)); Lie, K.H.; Peterson, E.W. Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 2.* Order Number DE89009077/JAW. Available from NTIS, PC A21/MF A01.

In naturally or explosively fractured geologic media most of the permeability is associated with the fracture network, whereas most of the porosity resides within the matrix blocks. Thus, both levels of porosity, fracture and matrix, are important in controlling the transient migration of radioactive gases from an underground nuclear cavity to the earth's surface. A numerical model of a double-porosity medium is used to investigate the upward transport of contaminant resulting from a moderate post-collapse overpressure in the chimney and/or cyclical pumping due to atmospheric pressure variations. It is found that the threat of rapid arrival through fractures is greatly mitigated by the process of Fickian diffusion which filters the contaminated gases as they rise through the fractures. Because of differences in concentration, contaminant species are drawn out of the rising gases into the surrounding porous matrix which contains relatively fresh air. The effectiveness of this Fickian filtering process depends on the aperture and spacings of fractures. Thus, consideration is given to the question of estimating these parameters of a double-porosity medium using field measurements such as the barometric pressure data reported by Hanson and Hearst at the previous containment symposium. Although the fracture/matrix interaction can be beneficial in buffering a strong first arrival of radiation, it can also give rise to a ratchet-like dispersion mechanism during

successive cycles of oscillatory motion, as described by Peterson, Lie and Nilson in this symposium.

47906 (CONF-870961–Vol.2, pp. 340-360) **Dispersion of contaminant during oscillatory gas-motions driven by atmospheric pressure variations.** Peterson, E.W. (Maxwell Labs., Inc., San Diego, CA (USA)); Lie, K.; Nilson, R.H. Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 2.* Order Number DE89009077/JAW. Available from NTIS, PC A21/MF A01.

Cyclical variations in atmospheric pressure cause vertical oscillatory motions of gases within the permeable earth. In an idealized homogeneous porous medium having uniform velocity at every elevation the induced motions would be piston-like and reversible, and they would contribute nothing to the net vertical transport of radioactive gases. However, in any real geologic medium there are nonhomogeneities occurring on many different length scales (from the spacing of major fractures to the grain-size of the rock) which cause the oscillatory motions to be shaggy and irreversible and ratchet-like. The macroscale expression of these nonuniformities is diffusion-like in nature and it is generally referred to as dispersion. Three different sequences of laboratory experiments were performed with the following results. (1) In a homogeneous sand column oscillatory motions cause no appreciable increase in the transport of tracer, as compared to a motionless experiment, in keeping with theoretical expectation. (2) Non-homogeneous media were first modeled using a central column of high permeability sand surrounded by an annulus of lower permeability sand. Dispersive transport along the column was substantially increased by the interaction between the two media, as verified by comparing results obtained for pumped columns with and without a partition tube between the central column and the annulus. (3) Another dispersive medium was constructed by emplacing a sequence of annular discs in a column of uniform sand. Results obtained with and without pumping were very different, in contrast with the homogeneous experiments in (1). Physical arguments, order of magnitude analyses, and numerical calculations are used to explain the outcome and to extrapolate to the field scale of interest.

47907 (CONF-870961–Vol.2, pp. 363-372) **High fluid levels in drill holes, Yucca Flat, Nevada Test Site.** Hoover, D.L. (Geological Survey, Denver, CO (USA)); Trudeau, D.A. Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 2.* Order Number DE89009077/JAW. Available from NTIS, PC A21/MF A01.

Between 1962 and 1986, the sustained effects of underground nuclear tests on water levels were investigated in six drill holes in Yucca Flat. This report identifies 33 drill holes that have high fluid levels (levels of any drilling fluid that are above the water table of Doty and Thordarson, 1983) or high water levels (formation water levels that are above previously measured static water levels). The authors conclude that (1) high fluid levels are more abundant where 20 or more nuclear tests within a 2,440-m radius were detonated near or below the water table, (2) high fluid levels are probably cumulative, and (3) the top of complete zeolitization of volcanic rocks has no apparent relation to drill holes that have high fluid or water levels.

47908 (CONF-870961–Vol.2, pp. 373-386) **Temperature logging as an aid to understanding groundwater flow in NTS boreholes.** Conaway, J. (Los Alamos National Lab., NM (USA)). Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 2.* Order Number DE89009077/JAW. Available from NTIS, PC A21/MF A01.

A temperature log in a thermally stable borehole through a uniform geologic formation would normally show essentially a straight line, with the temperature increasing slowly with depth at a rate corresponding to the local geothermal gradient. Changes in the slope of this line can result from many factors. In the case where groundwater is entering the borehole at one depth and exiting at another depth (or at the surface) the temperature disturbance resulting from this flow is likely to be a prominent feature of the temperature profile of the borehole. Temperature logs have been run using special procedures in exploration and satellite holes, where unusual groundwater behavior has been noted, at the NTS. These logs are useful in understanding the groundwater flow in those boreholes.

47909 (CONF-870961–Vol.2, pp. 387-398) **Geologic and hydrologic investigations at the ALEMAN (U3KZ) site, and other sites in Yucca Flat, the Nevada Test Site.** Hawkins, W.L. (Los Alamos National Lab., NM (USA)); Cavazos, A.P.; Thompson, P.H. Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 2.* Order Number DE89009077/JAW. Available from NTIS, PC A21/MF A01.

Water removed from U3kz, an emplacement hole (ALEMAN) which had developed a leak in the liner, was found to contain large amounts of tritium and some fission products. The source, at least for the fission products, is believed to be an event 337 m to the north of U3kz conducted nine years earlier. Ue3e, a nearby exploratory hole (65 m north of U3kz) drilled to investigate these findings, made similar discoveries. A packer test in Ue3e revealed unexpectedly high hydraulic pressures at depth. Hole U3cn #5 was drilled a little more than two years after the detonation of BILBY (U3cn) in September, 1963, approximately 122 m southwest of the event. Fractures in core from this hole were found to contain radionuclides. Similarly a cored exploratory hole (Ue4g #2) drilled in late 1977 for the ICEBERG event, encountered radionuclides in fractures. These fission products are believed to have traveled some 320 m from the source event (LATIR) executed in February 1974. Three sites (including ALEMAN) near the center of the valley, just west of the Yucca Fault, have revealed unanticipated hydrologic conditions. All are in a similar geologic setting. These sites were drilled with large diameter (> 1.5 m) emplacement holes and have smaller diameter nearby exploratory or satellite holes. The emplacement holes were lined from below the working point to above the predicted top of the static water level (SWL). Two of the three emplacement holes developed leaks in their liner. Five other sites in the same general area had water flowing into the hole over the top of the liner and another site had a liner which leaked. These conditions may have been the result of hydraulic pressures greater than anticipated. Hydrologic data from three of these recent sites is reviewed.

47910 (CONF-870961–Vol.2, pp. 401-413) **Development for centrifuge modeling of buried explosions.** Brown, J.A. (Los Alamos National Lab., NM (USA)); House, J.W.; Wohletz, K.H.; Gaffney, E.S. Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 2.* Order Number DE89009077/JAW. Available from NTIS, PC A21/MF A01.

The authors are developing test bed construction and instrumentation techniques for monitoring ground shock of contained subscale HE bursts (~45 gm C-4) that will be conducted on a large centrifuge. Reproducibility of the test medium has been a problem, but construction in a series of lifts of known volume and mass appears to produce good results. Instrumentation has included several types of stress transducers (piezoresistive: manganin and carbon; and piezoelectric polyinylidene fluoride), a mutual inductance particle velocity gauge, and accelerometers. Good ground shock records have been obtained. The authors have assembled a multichannel digital data acquisition system which can be transported to other sites such as a centrifuge facility. They have also obtained measurements of cavity and collapse crater sizes. Initial centrifuge tests will begin in the fall of 1987.

47911 (CONF-870961–Vol.2, pp. 414-429) **Development of centrifuge modeling for evaluating the mechanisms of collapse of underground opening.** Davis, B.C. (Lawrence Livermore National Lab., CA (USA)); Kutter, B.L.; Chang, J.D.L. Sandia National

Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 2.* Order Number DE89009077/JAW. Available from NTIS, PC A21/MF A01.

Improved prediction of surface collapse above an underground cavity is important in many LLNL programs, including nuclear testing. To improve predictive capability it is necessary to achieve a better understanding of the mechanisms involved in the process of collapse. This research aims to develop the centrifuge technique for modeling mechanisms of underground collapse in soil. The authors will also evaluate the adequacy of existing constitutive or flow models of soils in relation to the problem of underground collapse. In scale model tests involving problems such as underground collapse where gravity is a major driving force, the forces of gravity must be scaled to make the model simulate the actual event or prototype. Gravity can be scaled by placing the models in a centrifuge, where they are subjected to a steady centripetal acceleration many times greater than the earth's gravity. The authors also consider other factors in their effort to maintain similarity between model and prototype. Mechanical properties such as permeability, shear strength, density, and moduli must be the same in the model as in the prototype. The modeling tests were performed in Monterey 0/30 sand, Fountainbleau sand or Nevada Test Site (NTS) Area 2 alluvium. Development of the method consisted of testing several different scale models (at varying gravity levels). This is called modeling of models. If the various models predict the same prototype behavior, then the scaling laws and test procedure are verified over the range of scale factors spanned by the models. The test results validated the modeling laws as applied in the experiments reported here.

47912 (CONF-870961–Vol.2, pp. 430-445) **Trends in cavity collapse data.** Deupree, R.G. (Los Alamos National Lab., NM (USA)); Noel, S.D.; Watson, C.A. Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 2.* Order Number DE89009077/JAW. Available from NTIS, PC A21/MF A01.

Los Alamos National Laboratory has now measured the dynamics of cavity collapse using time domain reflectometry on over thirty Los Alamos nuclear weapons tests. A new system which greatly facilitates the collection and storage of this data is described. The authors have studied this collection of data and have been able to form a few conclusions: (1) the average rate of fall varies from 5 to 95 m/s, but most events fell into a group with average fall rates between 20 and 50 m/s, (2) the rate of fall generally increases toward the surface, and (3) the final (i.e., post-surface collapse) crush of the cable is generally located 25-100 m to the surface, suggesting that the material located above this depth tends to fall as a block. This depth may be location dependent. While these general trends are present, it should be noted that at least one counter example can be found for nearly every conclusion.

47913 (CONF-870961–Vol.2, pp. 446-455) **Photogrammetric method for determining sink volumes at the Nevada Test Site.** Garcia, M.N. (Geological Survey, Denver, CO (USA)). Sandia National Labs., Albuquerque, NM (USA). 1987. From 4. symposium on containment of underground nuclear explosions; Colorado Springs, CO (USA); 21-24 Sep 1987. In *Fourth symposium on containment of underground nuclear explosions. Proceedings: Volume 2.* Order Number DE89009077/JAW. Available from NTIS, PC A21/MF A01.

A procedure has been developed that utilizes a computer-assisted PG-2 photogrammetric plotter to measure the volumes of sinks formed following detonation of underground nuclear devices. Volumes determined by this procedure are more precise than those measured in the field. A detailed field measurement of the sink cannot be made because of possible hazards, thus, the few measurements commonly simplify the sink dimensions and ignore the sag zone, the area of minor subsidence just beyond the sink's perimeter. This sag zone commonly accounts for 5-20% of the sink's total volume and must be included in the final volume measurement. Field measurements are also time consuming and may not be recorded until days or weeks after surface collapse. As the photogrammetric procedure relies on photographs taken as soon as possible after collapse, and because the dimensions of the sink, including the sag zone, can be measured more precisely, a better interpretation of the effects of the explosion can be made.

47914 (UCID–21528) **Kernville ammonia system.** Clay, J.P.; Smuda, P.A.; Thole, K.A. Lawrence Livermore National Lab., CA (USA). 10 Apr 1989. 26p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE89016681/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

An environmental system was designed for the Kernville device canister to maintain a specified temperature and humidity inside the canister before, during, and after the canister was emplaced 550 m (1800 ft) below the earth's surface. Heating and temperature control were accomplished by strip heaters located in a duct that circulates the environmental gas. Cooling was done by an indefinite-life, cascade refrigeration system, in which the primary refrigerant was ammonia (R-717). The humidity was controlled by sending dry gas downhole and bubbling it through water as needed. The cooling system design was unique because the ammonia was cooled uphole to a liquid state, as opposed to using a conventional compressor. The cooling system was also unique because the uphole ammonia condenser was separated from the downhole evaporator by a vertical distance of 550 m (1800 ft). A water/ethylene-glycol heat-exchange loop was added as an intermediate loop to isolate the ammonia from the device canister. In case the downhole system failed, a limited-life, downhole ice-storage system was available as a backup. This environmental system was tested and used on the Kernville device canister and was operational in the field during January and February of 1988. The design specifications were fully met. During normal operation, the deviations from the set points were a full order of magnitude smaller than the allowed levels. The primary limitations to temperature and humidity control were the accuracy with which they could be measured and the electronic noise associated with the wiring and circuitry. 7 refs.

4503 Explosion Detection

47915 (CONF-890398–) **Proceedings of the DOE/LLNL symposium on Explosion-Source Phenomenology.** Patton, H.J.; Taylor, S.R. (eds.). Lawrence Livermore National Lab., CA (USA). 12 May 1989. 251p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. From DOE/LLNL symposium on explosion-source phenomenology; Lake Tahoe, CA (USA); 14-16 Mar 1989. Order Number DE89016501/JAW. Available from NTIS, PC A12/MF A01 - OSTI; GPO Dep.

The purpose of the Explosion-Source Phenomenology workshop was to bring together technical experts to summarize the state of knowledge of the underground explosion source based on US experience at the Nevada Test Site. Specifically, we wanted to summarize our knowledge of the explosion source, to identify limits of that knowledge and existing problems, and to propose directions of future research and data collection efforts. We also wanted to identify the dependence of results on assumptions made, on the effects of uncertainties in the data and methodology, and on limitations of the data to resolve question about the explosion source. The focus of the meeting was the effects of explosion-related phenomena on the character of local, regional, and teleseismic recordings of seismic waves. The workshop was divided into three areas; with a total of thirty-four research topics being presented. The three areas were: (1) near-field observations and modeling, (a) free-field and surface measurements, (b) small-scale lab measurements, (c) source region phenomenology. (2) far-field observations and modeling, (a) teleseismic measurements, (b) regional measurements, (3) forward modeling from code calculations using constitutive material relations. Individual projects are processed separately for the data bases.

47916 (SAND–89-2121C) **Seismic verification studies at Sandia.** Chael, E.P. Sandia National Labs., Albuquerque, NM (USA). [1989]. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-8908141–1: U.S. Department of Energy conference on technology research and development for arms control verification, Los Alamos, NM (USA), 29-31 Aug 1989). Order Number DE89017232/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Seismic Verification Program at Sandia focuses on designing and building seismic monitoring systems which could be deployed within the Soviet Union. To support this effort, Sandia also is involved in developing and testing seismic components, and in evaluating system performance and new monitoring techniques. Seismic studies conducted under the latter task concentrate on analyzing regional seismic signals, recorded within 2000 km of the source. In-country monitoring stations would be able to exploit these regional signals to improve on the capabilities of external stations at teleseismic ranges. The principal advantages which regional signals offer are greater amplitudes and broader frequency bands. However, such signals are more complex and less well understood than teleseismic records. Ongoing studies at Sandia will help define the performance which can be expected from an in-country network. Other studies are testing new monitoring concepts which may further improve in-country capabilities. This presentation gives a brief overview of some of these projects.

47917 (UCRL–101542) **Non-intrusive verification.** Ebert, P.J. Lawrence Livermore National Lab., CA (USA). 17 Jul 1989. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8908141–3: U.S. Department of Energy conference on technology research and development for arms control verification, Los Alamos, NM (USA), 29-31 Aug 1989). Order Number DE89017542/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A high-altitude nuclear explosion will produce a magnetic disturbance that is detectable at very large distances. The same effect is produced in an underground explosion and is detectable, but at much shorter distances. If the magnetic effect can be developed as a means of TTBT verification, it would be non-intrusive and applicable over a broad range of nuclear yields, perhaps to as low as 1 kiloton. This report identifies several technical advantages of this approach to verification, estimates the strength of detectable signals, and proposes a straightforward experiment that would lead to its development. 6 refs.

50 ENVIRONMENTAL SCIENCES, ATMOSPHERIC

47918 (IC–89/143) **Distribution and seasonal variations of diffuse fraction.** Anane-Fenin, K. International Centre for Theoretical Physics, Trieste (Italy). Jun 1989. 23p. Order Number DE90601303/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

A moving average approach is used to develop linear and polynomial regression models for the diffuse fraction averaged over 10, 15, 20 and 30 days. The correlations do not appear to be influenced by climate conditions or altitude. It is noted that the correlations vary with season. The time-dependent variations of the diffuse fraction correlations are examined by studying the residual differences between the measured diffuse fraction and those calculated from the over-all best-fit correlation. The residuals exhibit no pronounced pattern leading to the conclusion that the observed seasonal variation is caused by air mass and water vapour and that atmospheric turbidity plays little or no part. (author). 14 refs, 9 figs, 8 tabs.

5001 Basic Studies

Refer also to citation(s) 47636, 47637, 47664

47919 (LA-UR–89-2964) **A desk-top computer forecast for emergency response planning.** Yamada, T.; Bunker, S.; Williams, M.; Bice, B. Los Alamos National Lab., NM (USA). 1989. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-8907103–7: Technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). Order Number DE89016783/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The purpose of the study is to demonstrate the feasibility of running a three-dimensional weather forecast model on a desk-top computer. For emergency response planning, the ability to forecast wind, temperature, and atmospheric turbulence is essential in order to predict the transport and diffusion of an accidental release of toxic materials. We must follow a plume for a long distance to meet tighter regulations to protect human health and the environment. Most models for emergency response are based on the assumption that wind and turbulence conditions at the time of the release will be representative over the period for which dispersion must be predicted. For small releases where the principal concern is within the first few kilometers of travel, such an assumption is appropriate. However, for large releases during stable conditions, the plume may travel for several hours and the assumption of persistence is invalid. Under these circumstances a model which can forecast changes in wind and turbulence conditions is required. 6 refs., 3 figs.

5002 Chemicals Monitoring and Transport

Refer also to citation(s) 46912, 46915, 47316, 47463, 47640, 47641, 47642, 47709, 47985, 48029, 48153, 48154, 48155

47920 Kinetics of the reactions of chlorinated alkynes with atomic oxygen: The application of a new experimental technique. Russell, J.J. (Illinois Institute of Technology, Chicago (USA)); Senkan, S.M.; Seetula, J.A.; Gutman, D. pp. 2072 of Twenty-second symposium (international) on combustion. The Combustion Institute, Pittsburgh, PA (1989). From 22. international symposium on combustion; Seattle, WA (USA); 14-19 Aug 1988.

The kinetics of the reactions of oxygen atoms with acetylene and chlorinated acetylenes were investigated using a new experimental procedure which is described in detail. Both reactants were produced simultaneously in a tubular reactor coupled to a photoionization mass spectrometer by pulsed 193 nm laser photolysis. Sulfur dioxide was the O-atom source, and photolysis of halogenated olefins provided the appropriate alkyne. The decay of the alkyne was monitored in time-resolved experiments under pseudo first-order conditions (O atoms in large excess). The accuracy of the method is demonstrated with measurements of the O + C_2H_2 rate constant between 370 and 876 K. Rate constants of the O + 1-chloroprop-1-yne reaction were determined between 298 and 876 K and fit to an Arrhenius expression: 3.9×10^{-11} exp(-2.1 kcal mol^{-1}/RT) cm^3 $molecule^{-1}$ s^{-1}. An upper limit for the O + C_2Cl_2 rate constant at 823 K was also determined (1.6×10^{-13} cm^3 $molecule^{-1}$ s^{-1}). The utility of the method for the study of the kinetics of other O-atom reactions with molecular reactants which can be produced by 193 nm photolysis of suitable precursors is discussed.

47921 (CONF-881054–Vol.4, pp. 1177-1188) **Characterization of the atmospheric pathway at hazardous waste sites.** Droppo, J.G. Jr. (Pacific Northwest Lab., Richland, WA (USA)); Buck, J.W. Analysas Corp., Oak Ridge, TN (USA). 1988. DOE Contract AC06-76RL01830. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

Evaluation of potential health effects for populations surrounding hazardous waste sites requires consideration of all potential contaminant transport pathways through groundwater, surface water, and the atmosphere. A comprehensive atmospheric pathway model that includes emission, dispersion, and deposition computations has been developed as a component of the Remedial Action Priority System (RAPS). RAPS is designed to assess the relative potential risks associated with hazardous and radioactive mixed-waste disposal sites. The atmospheric component includes optional volatilization and suspension emission routines. Atmospheric transport, dispersion, and deposition are computed using relatively standard modeling techniques expanded to incorporate topographical influences. This sector-averaged Gaussian model accounts for local channeling, terrain heights, and terrain roughness effects. Long-term total deposition is computed for the terrain surrounding the hazardous waste site. An example is given of applications at a US Department of Energy site, where atmospheric emissions are potentially important. The multiple applications of RAPS have provided information on the relative importance of different constituent transport pathways from a potential population risk basis. The authors results show that the atmospheric pathway is often equally as important as other pathways such as groundwater and direct soil ingestion.

47922 (CONF-881054–Vol.4, pp. 1359-1366) **Managing the asbestos abatement process.** White, E.R. Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

Managing asbestos abatement projects do not vary greatly from other construction-related projects. Scheduling, cost controls, bonding, insurance, preliminary planning, permitting, etc., are all common denominators in any construction process. The two major issues requiring specials attention in asbestos-related projects are controlling asbestos fibers during abatement and reducing long-term liability associated with the waste materials.

47923 (CONF-890692–20) **Contribution of deforestation to atmospheric CO_2 and reforestation as an option to control CO_2.** Kinsman, J.D.; Marland, G. Oak Ridge National Lab., TN (USA). 1989. 29p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 82. Air and Waste Management Association annual meeting and exhibition; Anaheim, CA (USA); 25-30 Jun 1989. Order Number DE89017255/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In this paper we discuss various aspects of global climate change as related to forests: the rate of deforestation; CO_2 emissions resulting from deforestation; and reforestation as a means to control atmospheric CO_2. We also include for perspective a discussion of current policy considerations related to methods for reducing deforestation or promoting reforestation. 68 refs.

47924 (CONF-8803229–) **Ozone depletion, greenhouse gases, and climate change: Proceedings.** National Research Council, Washington, DC (USA). Board on Atmospheric Sciences and Climate; National Research Council, Washington, DC (USA). Committee on Global Change. 1989. 122p. Sponsored by DOA;DOD;DOE/ER;DOI;DOT;EPA;NASA;NSF. DOE Contract AI01-87ER60590. NA87-AA-D-CP041. From Joint symposium on ozone depletion, greenhouse gases and climate change; Washington, DC (USA); 23 Mar 1988. Order Number DE89016111/JAW. Available from NTIS, PC A07/MF A01; OSTI; National Academy Press, 2101 Constitution Ave., NW, Washington, DC 20418 $20.00; GPO Dep.

This symposium was primarily concerned with the linkages between ozone depletion and increasing greenhouse gases and with their combined effect in causing climate change to occur on a global scale. The presentations in these proceedings review the current state of knowledge about stratospheric ozone depletion, discuss the probable effect of predicted greenhouse gas increase on future ozone trends, summarize observational data on changing atmospheric chemistry and associated atmospheric temperatures, and describe the continuing effort to model and predict future scenarios of climatic change relative to ozone and greenhouse gases in both the stratosphere and the troposphere. Some of the questions and answers that followed the presentations have been included when they highlight noteworthy points that were not covered in the presentation itself. The request by the National Climate Program Office for a symposium on the above related issues is included. The symposium agenda and participants are given. As well as a glossary of special terms and abbreviations. In summary, the Joint Symposium on Ozone Depletion, Greenhouse Gases, and Climate Change reviewed the magnitude and causes of stratospheric ozone depletion and examined the connections that exist between this problem and the impending climate warming to increasing greenhouse gases. The presentations of these proceedings indicate that the connections are real and important, and that the stratospheric ozone depletion and tropospheric greenhouse warming problems must be studied as parts of an interactive global system rather than as more or less unconnected events.

47925 (LA-UR–89-2858) **Air quality studies in the western United States.** Yamada, T. Los Alamos National Lab., NM (USA). [1989]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-8907103–5: Technology-based confidence building: energy and environment, Santa Fe, NM (USA), 9-14 Jul 1989). Order Number DE89016984/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Los Alamos investigators participated in SCENES, WHITEX, Winter Intensive Tracer Experiments conducted from January 7 through February 18, 1987, in the area 400 km (east-west) x 250 km (north-south) centered around Page, Arizona. The purpose of the experiment was to quantify the attribution of a local source (Navajo Generating Station) and remote sources (copper smelters in southern Arizona, Mojave generating station, power plants and large urban areas) to the haze occurrences in the Grand Canyon and Canyonlands National Parks, and Glen Canyon National Recreation area. In order to "tag" plumes emitted from the Navajo Generating Station (NGS), a trace gas was released from the NGS stack during the entire experimental period. The purpose of this paper is to illustrate, by using Los Alamos three-dimensional atmospheric flow models, large diurnal and spatial variations of wind, turbulence and plume characteristics over complex topographic areas. 7 refs., 6 figs.

47926 (N–89-21287, pp. 196-197) **Effects of global atmospheric perturbations on forest ecosystems: Predictions of seasonal and cumulative effects.** Tinus, R.W. (Geological Survey, Flagstaff, AZ (USA)); Roddy, D.J. Lunar and Planetary Inst., Houston, TX (USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird, UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history: An interdisciplinary conference on impacts, volcanism, and mass mortality.* Available from NTIS, PC A11/MF A01.

The physical effects of certain large events, such as giant impacts, explosive volcanism, or combined nuclear explosions, have the potential of inducing global catastrophes in our terrestrial environment. Such highly energetic events can inject substantial quantities of material into the atmosphere. In turn, this changes the amount of sunlight reaching the Earth's surface and modifies atmospheric temperatures to produce a wide range of global effects. One consequence is the introduction of serious stresses in both plants and animals throughout the Earth's biosphere. For example, recent studies predict that forest lands, crop lands, and range lands would suffer specific physical and biological degradations if major physical and chemical disruptions occurred in our atmosphere. Forests, which cover over 4 times 10 to the 9th power hectares (4 times 10 to the 7th power sq km) of our planet, or about 3 times the area now cultivated for crops, are critical to many processes in the biosphere. Forests contribute heavily to the production of atmospheric oxygen, supply the major volume of biomass, and provide a significant percentage of plant and animal habitats.

47927 (ORNL/FTR–2818) **[Development of a global vegetation model]: Foreign trip report, February 15–20, 1988.** Emanuel, W.R. Oak Ridge National Lab., TN (USA). 1 Mar 1988. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017404/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The International Institute for Applied Systems Analysis (IIASA) is beginning the development of a global vegetation model. Travel as part of collaboration in that effort is reported. The IIASA model will describe the growth and maintenance of vegetation and its transient and steady-state dependence on climate. A major international conference in April 1988 will summarize and evaluate available concepts, data, and formalisms that might be incorporated in the model. The model will be designed by participants in an extended workshop during the summer of 1988. IIASA staff will implement the model during the fall and winter of 1988. The traveler will participate in both the conference and the extended workshop. During this trip, he assisted with planning for these activities, coordinated preliminary work with IIASA staff, and discussed ongoing IIASA environmental research with a number of investigators.

47928 (ORNL/FTR–3082) **[Responses of coniferous species to atmospheric CO_2 enrichment]: Foreign trip report, September 19–30, 1988.** Luxmoore, R.J. Oak Ridge National Lab., TN (USA). 14 Oct 1988. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017376/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler presented an invited review paper on responses of coniferous species to atmospheric CO_2 enrichment at an International Union of Forestry Research Organizations (IUFRO) Conference in the Soviet Union and a contributed paper coauthored

with J. Saldarriaga on the solar conversion efficiency of a tropical rain forest at an IUFRO symposium in France. The traveler chaired a session at each conference and participated in IUFRO business meetings. The Soviet meeting was attended by 70 participants from 9 countries and provided a rare opportunity to meet a large number of Soviet tree physiologists. Many potentially useful contacts were established for several different geographic regions of the USSR. There were 400 participants from 40 countries at the meeting in France, and the research presentations ranged from biochemistry to ecology. An ad hoc meeting on CO_2 and climate change was held, and tentative plans for developing cooperation through IUFRO were initiated. A project proposal on hierarchical plant processes was supported and will be developed by the traveler for approval by the IUFRO Executive Board. 7 refs.

47929 (ORNL/FTR–3121) **[Workshop on the Biospheric Model Validation Study (BIOMOVS)]: Foreign trip report, November 7–11, 1988.** Blaylock, B.G. Oak Ridge National Lab., TN (USA). 22 Nov 1988. 24p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017418/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The seventh workshop of the Biospheric Model Validation Study (BIOMOVS), held at the Japan Atomic Energy Research Institute (JAERI) at Tokai, was attended by Dr. B.G. Blaylock from the ORNL. BIOMOVS is an international cooperative effort to test models designed for calculating environmental transfer and bioaccumulations of radionuclides and other trace substances. The purpose of the workshop was to compare model predictions with independent data sets. Comprehensive data from the Chernobyl accident for 14 sites have been provided for model testing. These data permit the evaluation of secondary model parameters, such as the contribution of inhalation by cows to the concentration of ^{131}I in milk. Results of the final report for the scenario, "Mercury in Aquatic Ecosystems," were presented.

47930 (ORNL/FTR–3148) **[Effects of air pollution on forest productivity in Southern Sweden]: Foreign trip report, December 4–9, 1988.** McLaughlin, S.B. Jr. Oak Ridge National Lab., TN (USA). 19 Dec 1988. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017366/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler visited Sweden on December 4-9, 1988, at the request of the Swedish Agriculture University to serve as an advisor to the recently initiated Skogaby Project. The Swedish Skogaby Project is a >$1 million per year research effort addressing interrelationships between air pollution, tree vitality, and forest production in southern Sweden. Eight treatments are currently being utilized in a 22-year-old Norway spruce stand to identify the principal factors controlling tree responses to varying water and nutrient availability. The traveler's recommendations for the final planning and coordination phases emphasized focusing the series of specific questions on shifts in resource allocation induced by each treatment into a more specifically defined research strategy designed to direct sampling effort to key interactions during the periods of maximum resource demand. The use of high-resolution dendrometer band data to document the distribution and kinetics of stem growth, the temporal stratification of sampling keyed to ambient pollution exposure episodes, and the potential utility of subplot treatment with soluble base cations to substantially increase soil Ca:Al levels was also suggested. The traveler's seminar emphasized regional growth patterns for red spruce and loblolly pine and tests of hypotheses of action of acid deposition, ozone, gaseous NO_x, wet deposited H_2O_2, and aluminum in soils.

47931 (ORNL/FTR–3195) **[Collection of North Pacific Ocean surface seawater samples from a container ship]: Foreign trip report, January 24–March 4, 1989.** Goddard, J.G. Oak Ridge National Lab., TN (USA). 16 Mar 1989. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017371/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This trip was a continuation of the sampling program undertaken during 1984–1985 to study the seasonal and regional variability of CO_2 chemistry in high-latitude deep water formation areas of the North Pacific. The work is conducted by Columbia University (Dr. Taro Takahashi, Principal Investigator) for the Department of Energy's Energy Systems Program managed by Oak Ridge National Laboratory. Aboard the President Eisenhower, we collected surface seawater samples at forty-two stations along the route from Oakland, California, to Keelung, Taiwan, via Guam. On the return trip, samples were collected from thirty-nine stations during transit from Kaohsiung, Taiwan, to Los Angeles, California.

47932 (ORNL/FTR–3213) **[Analysis of vegetation responses to changes in the global environment]: Foreign trip report, March 29, 1989–April 7, 1989.** Emanuel, W.R. Oak Ridge National Lab., TN (USA). 24 Apr 1989. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017391/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Dr. Emanuel is a member of an international team working to analyze vegetation responses to changes in the global environment, particularly climate. The work is coordinated by Dr. Allen M. Solomon, the director of the Biosphere Project of the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria. This report summarized a team meeting held in Sofia, Bulgaria, April 3-5, 1989.

47933 (ORNL/TM–11121) **1988 annual report of the Integrated Forest Study.** Lindberg, S.E.; Johnson, D.W. (eds.). Oak Ridge National Lab., TN (USA). Jun 1989. 233p. Sponsored by Electric Power Research Institute. DOE Contract AC05-84OR21400. Order Number DE89015677/JAW. Available from NTIS, PC A11/MF A01 - OSTI; GPO Dep.

Environmental Sciences Division Publication No. 3339.

The summaries contained in this report describe the trends in atmospheric deposition, canopy interactions, soil solution fluxes, and ecosystem budgets for the major chemical species studies in the Integrated Forest Study (IFS). This document also includes summary reports of each supportive deposition and soils experimental task, and descriptions of specific field research performed at each site. This report is one of a series of reports on the IFS, including Site Descriptions, Measurement Protocols, and Project Summary. Preliminary analysis of the deposition and nutrient cycling data indicated several interesting trends across sites. The deposition estimates confirm the expected increase in atmospheric deposition at high elevation sites compared to lower elevation forests. Input to the Smoky Mountains site in the Southeast exceeded that to all other sites for most chemical species. Cloudwater interception, enhanced dry deposition due to high wind speeds, and increased rainfall due to orographic effects all contribute to this trend. At the other sites dry deposition was important in the input of all ions, particularly at the dryer southeastern sites and most significantly for the base cations. Canopy interactions were minimal for deposited Na and S, but indicated significant canopy absorption of strong acidity and N, and foliar leaching of base cations at all forests.

47934 (PB–89-167944/XAB) **Short-term trends and spatial variability in precipitation chemistry in the South Coast Air Basin. Final report.** Hoffmann, M.R. California Inst. of Tech., Pasadena, CA (USA). 28 Feb 1989. 187p. Available from NTIS, PC A09/MF A01.

Automated sub-event sequential rain samplers were used to sample rain during the winter and spring of 1987 in the South Coast Air Basin. Rainwater pH levels varied from 4 to 6 at West Los Angeles and Henninger Flats, from 4 to 5.5 at Pasadena, from 4.3 to 5.7 at Mt. Wilson, and from 4.5 to 6.8 at Riverside. Measurements of the atmospheric burdens of aerosol and gas-phase species prior to a storm indicated that considerably more N(V) and S(IV) were deposited in rainfall than could be accounted for by pre-storm atmospheric burdens of these species while pre-storm burdens of Ca(2+), Mg(2+), Na(+), and N(III) were closer to the measured deposition of these species in the rainfall. Concentrations of Na(+), Ca(2+), and Mg(2+) were observed to be higher in larger droplets, and concentration of SO(4)(2-), NO(3-), NH(4+) and H(+) were higher in the small droplets. Aerosols and fog- and cloud water were sampled during the Southern California Air Quality Study to assess the role that fog and cloud play in the formation of aerosols in the South Coast Air Basin and to quantify the scavenging of precursor aerosol and gases during droplet formation.

47935 (PB–89-181093/XAB) **Chemical Mass Balance (CMB) Receptor Model (Version 6.0) (for microcomputers). Model-Simulation.** Nguyen, Q.T. Environmental Protection Agency, Research Triangle Park, NC (USA). Office of Air Quality Planning and Standards. 20 Jul 1987. vp. Available from NTISCP D01.

The software is contained on 5 1/4-inch diskette, double density (360K), compatible with the IBM PC microcomputer. The diskettes are in the ASCII format. Price includes documentation, PB–89-181101.

The Chemical Mass Balance (Version 6.0) Receptor Model uses the chemical composition of an ambient particulate sample to estimate the relative contributions of different source categories to the measured particulate concentration. The chemical composition of each source category's emissions (source profile) must also be known in order to run the model. Software Description: The software is written in the Fortran 77 language for use on an IBM-PC or compatible machine using MS-DOS 2.0+ operating system. The system will operate with 320K memory.

47936 (PB–89-181218/XAB) **Regional analysis of wet deposition for effects research. Project report.** Vong, R.; Cline, S.; Reams, G.; Bernert, J.; Charles, D. Environmental Protection Agency, Corvallis, OR (USA). Environmental Research Lab. Feb 1989. 48p. (EPA–600/3-89/030). Available from NTIS, PC A03/MF A01.

The basis for regional analysis of precipitation amount, concentration and deposition is investigated. When performing such a spatial analysis, key issues are the data selection, data compositing, the interpolation technique, and the uncertainty of the results. Sources of data on precipitation amount and chemical composition are presented along with procedures for screening the chemical data. A review of recent work reveals that different scientists select different data sets and that data selection plays an important role in the resulting maps. Important issues in data preprocessing include temporal resolution, data stratification into geographic regions, and choosing between direct and indirect methods for interpolating wet deposition. Available spatial interpolation techniques are discussed. The geostatistical technique, kriging, is discussed in detail to allow other researchers the benefit of previous applications to precipitation chemistry. Procedures for generating and checking uncertainty estimates are discussed.

47937 (PB–89-181317/XAB) **Nitric acid shootout: field comparison of measurement methods (journal version).** Hering, S.V.; Allegrini, I.; Febo, A.; Perrino, C.; Sickles, J.E. Environmental Protection Agency, Research Triangle Park, NC (USA). Atmospheric Sciences Research Lab. 1988. 23p. (EPA–600/J-88/218). Available from NTIS, PC A03/MF A01.

Pub. in Atmospheric Environment, Vol. 22, No. 8, 1519-1539(1988).

Eighteen instruments for measuring atmospheric concentrations of nitric acid were compared in an eight-day field study at Pomona College, situated in the eastern portion of the Los Angeles Basin, in September 1985. The study design included collocated and separated duplicate samplers, and the analysis by each laboratory of a set of quality assurance filters, so that the experimental variability could be distinguished from differences due to measurement methods. For all sampling periods, the values for nitric acid concentrations reported by the different instruments vary by as much as a factor of four. Overall, the highest reported concentrations are observed with the filter packs and lower concentrations are observed by the annular denuders and tunable-diode-laser absorption spectrometers. When the nitric acid concentrations are high enough to be detected by the FTIR, the FTIR values are close to those obtained by the denuder difference method and to the mean value from the other sampler groups. In the absence of a reference standard for the entire study, measurement methods are compared to the average of four denuder difference-method samplers.

47938 (PB–89-184568/XAB) **Sampling and evaluating airborne asbestos dust: Course 582, 1988.** Bayer, S.G. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Div. of Training and Manpower Development. Mar 1988. 228p. Available from NTIS, PC A11/MF A01.

Also available from Supt. of Docs. See also PB–85-246023.

Contents include: agenda; course description; pretest; method: 7400; asbestos analysis; overloading and electrostatic effects; pump calibration; asbestos sampling - rules for good guessing; introduction to statistics; familiarization with the microscope; setting up the microscope - slide show; graticule calibration; Walton-Beckett images; filter mounting; quality-control testing of asbestos counts; method: 7402; method: 7403; and count sheets.

47939 (PB–89-186530/XAB) **Occupational hazards of laser-material processing. Final report, 1 October 1972-31 January 1975.** Rockwell, R.J.; Wilson, R.M.; Jander, S.; Dreffer, R. Cincinnati Univ., OH (USA). Coll. of Medicine. 21 May 1976. 38p. Available from NTIS, PC A03/MF A01.

The study was undertaken to define the nature and magnitude of laser material-processing uses and to examine the potential respirable hazards that might be released as part of the interaction plume from some of the more-commonly used industrial materials. A workforce of greater than 14,000 people were to some extent using lasers on a daily basis for material-processing applications on over 70 different materials. Lasers were used in the areas of drilling or welding of metals, ceramics, plastics, and diamonds. They were used for material cutting and scribing on natural and synthetic fabrics, paper, metals, and plastics. They were used in electronic component controlled fracturing of crystals and glass and material heating of metals, chemicals, and other substances. Eighteen laser-beam-related accidents that were related to ocular and skin hazards were reported. A general synopsis of current laser safety practices at industrial laser installations was also included. Laboratory experiments confirmed that hazardous gases can be produced in carbon dioxide cutting of plastics. In addition, respirable particulates were released in sufficient quantities in ruby laser drilling of metals to constitute a hazard. The authors conclude that proper ventilation of laser-material processing systems is essential.

47940 (PB–89-187314/XAB) **Fog, cloud, and dew chemistry. Final report.** Hoffmann, M.R. California Inst. of Tech., Pasadena, CA (USA). W.M. Keck Engineering Lab. of Hydraulics and Water Resources. 28 Feb 1989. 496p. Available from NTIS, PC A21/MF A01.

The spatial and temporal variations of fog/cloud chemistry were determined in the San Joaquin Valley, in the Los Angeles Basin, and in the Santa Barbara Channel area using automated fog- and cloudwater collectors that were designed and constructed for the project. A significant correlation was observed between the average nighttime cloud- and fogwater loadings of H^+ and NO_3^- and the maximum levels of O_3^-. Higher aldehydes, a series of dicarbonyls, and a variety of sulfonic acid salts formed by reaction of S(IV) and aldehydes were quantitatively determined in the droplet phase.

47941 (PB–89-187322/XAB) **Southern California Air Quality Study: Peroxyacetyl nitrate (PAN) measurements. Final report.** Williams, E.L.; Grosjean, D. Grosjean (Daniel) and Associates, Inc., Ventura, CA (USA). 24 Mar 1989. 149p. Available from NTIS, PC A07/MF A01.

See also PB–86-223427.

Measurements of peroxyacetyl nitrate (PAN) were carried out as part of the 1987 Southern California Air Quality Study. While PAN has long been observed in Southern California air, the authors study yielded for the first time information on the spatial and seasonal variations of PAN in the South Coast Air Basin. The highest PAN concentration during SCAQS, 30 ppb, was recorded at the Claremont site. Sumertime levels of PAN exhibited a strong increase from coastal to inland locations (PAN levels at the 'control' site, San Nicolas Island, were < 1 ppb), and a corresponding shift in daily maxima from mid-day at coastal sites to late afternoon inland. Thus, spatial variations of PAN during the summer were consistent with considerations of photochemical production during transport. In contrast, levels of PAN during the fall phase of SCAQS were high at the coastal locations, e.g. 13-19 ppb at all five winter SCAQS sites on December 3, 1987. PAN concentrations aloft were up to 30 ppb and were comparable to (and often higher than) those measured at ground level.

47942 (PB–89-187876/XAB) **Evaluation of dustiness test methods and recommendations for improved dust control at Heubach Inc., Newark, New Jersey. Study report.** Cooper, T.C.; Heitbrink, W.A.; O'Brien, D.M. National Inst. for Occupational Safety

and Health, Cincinnati, OH (USA). Div. of Physical Sciences and Engineering. Feb 1989. 57p. (ECTB–154-11A). Available from NTIS, PC A04/MF A01.

A study was made of methods in place at the Heubach Inc. facilities located in Newark, New Jersey for the control of dust during the production of inorganic lead chromate and organic pigments. The study centered in the bag-filling area of a particular building and in the bag-emptying area of a second building. A 15-year-old St. Regis force-flow packer and a 20-year-old St. Regis auger packer were used to package pigment in multiple paper bags in 50-pound quantities. In the bag-emptying area semibulk or sling type bags, fiber drums, and 50-pound paper bags were emptied at one of five dump stations. A number of practices were used by this company to reduce worker dust exposures. These included product modification, process equipment design, local exhaust ventilation, personal protective equipment, and administrative controls. Some of the lead pigments were modified by using a proprietary additive to reduce their dustiness. Other equipment controls were discussed. Personal protective equipment was provided. Each employee viewed a 90-minute video on safety once a year, and the importance of good hygiene was stressed. Also discussed was an evaluation of the dustiness test procedures and the correlation of the worker exposure with the dustiness test results. The authors recommend improved process design, ventilation and work practices for reducing lead exposures.

47943 (PB–89-187967/XAB) **Characterization of surface properties affecting the activity of the 'free silica' fraction of respirable dusts. Final report.** Wallace, W.E.; Keane, M.J. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). 1988. 25p. Available from NTIS, PC A03/MF A01.

A two-part study was conducted to investigate the surface properties of the quartz or 'free silica' fraction of respirable mine dusts. The degree of surface contamination of respirable quartz particles was studied using scanning electron microscopy with energy-dispersive x-ray analysis (SEM-EDX) to distinguish alumino/silicate and magnesium silicate surface occlusions from the silicate particles. By varying the electron-beam accelerating voltage, the depth of penetration could be reduced, so that the surface layer could be distinguished from the substrate material. Experiments were conducted on the relationship of measured SEM-EDX signal coming from the substrate to coating thickness and electron-beam accelerating voltage. In the second part, modifications were made of respirable-quartz-particle cytotoxicity by surface treatment. As measured by erythrocyte hemolysis and pulmonary macrophage release of lactate dehydrogenase in-vitro, respirable quartz cytotoxicity was neutralized by boiling in water in glass test tubes for 10 to 40 minutes. The membranolytic potential was reduced to near zero by boiling up to 10 milligrams of quartz per milliliter of water. Replacing the medium with fresh water midway through the boiling resulted in full detoxification. Preboiling the medium with silica reduced the effect. Detoxification persisted after mild drying at 110 C for 8 hours and persisted after 3 days of resuspension in water at room temperature.

47944 (PB–89-188007/XAB) **Health-hazard evaluation report HETA-87-300-0000, B. F. Goodrich Company, Marietta, Ohio.** Richardson, F.D.; Almaguer, D.; Mathias, C. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Div. of Surveillance, Hazard Evaluation and Field Studies. Jun 1988. 15p. (HETA–87-300-0000). Available from NTIS, PC A03/MF A01.

See also PB–88-236880.

A study was made of possible hazardous working conditions at the B.F. Goodrich Company, Marietta, Ohio. Of particular concern were cases of dermatitis possibly arising from skin exposure to substances handled on the job. The compounding and calendaring working environments were contaminated by powder and liquid spills. Ample opportunity existed for workers to contact the aziridine-based cross-linking agent, polyfunctional acrylates, methylmethacrylate, epoxy resins, and sulfonate used in printing and compounding processes. Skin patch testing was performed to test for dermal sensitization to agents used during the performance of normal activities. All Compounding personnel and Calendaring personnel associated with printing, ink production, and embossing who had dermatitis of the face, neck and/or arms, were asked to participate. The 126 persons tested represented 70% of persons employed in these departments. The authors recommend an educational program for workers, use of coveralls, better housekeeping in the Compounding Department and other areas of the facility, use of vacuum systems or wet mopping to remove accumulated dust, avoidance of food in work areas, improved ventilation system, use of organic vapor cartridge respirators, improved personal hygiene, use of barrier creams, and improved medical surveillance of dermatitis cases.

47945 (PB–89-188403/XAB) **Polycyclic aromatic hydrocarbons, particulates, and defense mechanisms (VKC-BAB-145). Final report.** Hahon, N. National Inst. for Occupational Safety and Health, Cincinnati, OH (USA). Sep 1988. 17p. Available from NTIS, PC A03/MF A01.

The interaction of polycyclic aromatic hydrocarbons, represented by benzo(a)pyrene (BaP), and particulates in carcinogenesis was investigated. The systemic administration of BaP has been shown to significantly depress the whole animal interferon response to viral stimulation, suggesting this may be an early expression of immunotoxicity. BaP requires bioactivation to inhibit interferon induction. The research activities and significant findings and accomplishments germane to BaP interaction with the interferon system were reviewed. It was noted that BaP metabolites can be discriminated by their adverse effect on interferon induction which correlated with mutagenic activity. The adverse effect of BaP on interferon induction was intensified when BaP was absorbed onto asbestos, coal dust, and metal particles but not when interacted with silicates. The authors conclude that the inhibition of virus induction of interferon may be gainfully used to detect and assess quantitatively the interactions of occupational-disease-related particles as well as mutacarcinogenic chemicals with other biologic systems and cellular elements.

47946 (PB–89-189450/XAB) **Pilot-scale HCl control by dry alkaline injection for emissions from refuse incinerators. Technical report.** Moore, D.; Pilat, M. Washington Univ., Seattle, WA (USA). Dept. of Civil Engineering. 8 Nov 1988. 26p. Available from NTIS, PC A03/MF A01.

One method of removing the HCl in an exhaust-gas stream is to directly inject finely divided sorbent particles into the gas stream upstream from particulate collection equipment, allowing enough time for the HCl to react with the sorbent in the duct. The study proposed to provide data on HCl removal from a simulated incinerator exhaust stream as a function of the in-duct reaction/residence time, the reaction temperature, and the sorbent-to-gas ratio. A 500-acfm pilot-scale HCl control system utilizing dry powdered sorbent was tested at the University of Washington. Powdered alkaline reagents including sodium bicarbonate and calcium hydroxide were injected into boiler flue gas spiked with hydrogen chloride gas. The acid gas reacts with the injected sorbent in a 20-inch diameter by 26-foot high vertical, down-flow vessel. HCl removal efficiency was measured as a function of sorbent stoichiometry, gas residence time in reactor, and reaction temperature.

47947 (PB–89-189849/XAB) **Paint coatings: Controlled field and chamber experiments.** Edney, E.O. Environmental Protection Agency, Research Triangle Park, NC (USA). Atmospheric Research and Exposure Assessment Lab. Apr 1989. 20p. (EPA–600/3-89/032). Available from NTIS, PC A03/MF A01.

To determine the impact of pollution levels on the weathering rates of coatings, laboratory chamber experiments and controlled field exposures at North Carolina and Ohio sites were conducted in such a manner to separate the contributions due to dry deposition, wet deposition, precipitation pH, etc. The results of these studies confirm that acidic gases such as SO_2 and HNO_3, as well as acids within rain, promote the dissolution of alkaline components including $CaCO_3$, ZnO, and Al flake from paint films. It is unclear from these studies whether the removal of these components reduces the service life or protective properties of the paint film. Other researchers within the Coatings Effects Program are conducting subsequent analyses to determine micro-damage of these paints. The uptake of acidic gases to painted surfaces is a complex process that depends on several factors. The deposition rate of SO_2 to a wet, painted surface may be controlled by the level of oxidants such as H_2O_2.

47948 (PB–89-189872/XAB) **Hospital incinerator operator training course. Volume 1. Student handbook. Final report.** Neulicht, R.M.; Chaput, L.S.; Wallace, D.D.; Turner, M.B.; Smith, S.G. Midwest Research Inst., Cary, NC (USA). Mar 1989. 254p. Available from NTIS, PC A12/MF A01.

See also PB–89-189880.

This document is Volume I of a three-volume training course for operators of hospital-waste incinerators. The course provides hospital-waste incinerator operators with a basic understanding of the principles of incineration and air pollution control and to identify good operation and maintenance (O&M) practices. Proper O&M, in addition to reducing air emissions, improves equipment reliability and performance, prolongs equipment life, and helps to ensure proper ash burnout. The course is not intended to replace site-specific, hands-on training of operators with the specific equipment to be operated. Volume I is narrative in style and can be used as a reference at the completion of the class. Review questions and answers for students are provided at the end of each classroom session. The course includes 11 separate classroom sessions covering topics such as basic combustion principles and incinerator design; air pollution control equipment design, function, operation, and monitoring; incinerator operation; maintenance inspections; typical problems; and State regulations.

47949 (PB–89-189880/XAB) **Hospital incinerator operator training course. Volume 2. Presentation slides. Final report.** Neulicht, R.M.; Chaput, L.S.; Wallace, D.D.; Turner, M.B.; Smith, S.G. Midwest Research Inst., Cary, NC (USA). Mar 1989. 243p. Available from NTIS, PC A11/MF A01.

See also PB–89-189872.

This document is Volume II of a three-volume training course for operators of hospital-waste incinerators. The course provides hospital waste-incinerator operators with a basic understanding of the principles of incineration and air pollution control and to identify good operation and maintenance (O&M) practices. Proper O&M, in addition to reducing air emissions, improves equipment reliability and performance, prolongs equipment life, and helps to ensure proper ash burnout. Volume II contains classroom materials including a copy of the presentation slides so that students can follow along during the class and worksheets that can be completed during the classroom sessions. The course includes 11 separate classroom sessions covering topics such as basic combustion principles and incinerator design; air pollution control equipment design, function, operation, and monitoring; incinerator operation; maintenance inspections; typical problems; and State regulations.

47950 (PB–89-190318/XAB) **Baghouse efficiency on a multiple-hearth incinerator burning sewage sludge.** Adams, R.C ; Keller, L.E.; Robb, E.V.; Vancil, M.C.; Farrell, J.B. Radian Corp., Research Triangle Park, NC (USA). Apr 1989. 216p. Available from NTIS, PC A10/MF A01.

See also PB–88-112164. Portions of this document are not fully legible.

A pilot-scale fabric filter (baghouse) was evaluated for its removal performance for 23 metals and for sulfur as well as for total particles when fitted to a multiple-hearth incinerator burning sewage sludge. The small-scale baghouse was installed to take a slipstream of about 3% of the total incinerator emissions. Particle size fractions were collected from the gas streams entering and leaving the baghouse. Each particle-size fraction was analyzed for the 24 elemental species and baghouse performance was evaluated for overall removal efficiency, size-fraction removal efficiency, and for selective removal of specific metals. Total concentrations of each element in the controlled emission stream was determined as well as the proportionate concentrations of species in the solid and volatile states. Concentrations of each metal in the emission stream was compared with the concentration in a sludge residue. To obtain comparisons of baghouse performance with a more typical emission control device, the performance of the incinerator's full-scale wet scrubber was also evaluated.

47951 (PB–89-190375/XAB) **Development of sampling methods for source PM10 emissions. Final report.** Williamson, A.D.; Farthing, W.E.; Dawes, S.S.; McCain, J.D.; Martin, R.S. Southern Research Inst., Birmingham, AL (USA). Apr 1989. 192p. Available from NTIS, PC A09/MF A01.

This report describes an investigation of the needs and available techniques for in-stack PM-10 sampling. Discussion includes the conceptualization, development, documentation, and testing of two candidate methods. The first method, Constant Sampling Rate (CSR), is a procedural approach which adds particle-size separation to sampling hardware that has been widely used in EPA Methods 5 and 17 but modifies the sampling protocol to accomplish the PM-10 objectives. The second method, Exhaust Gas Recycle (EGR), is an equipment approach which accomplishes the PM-10 objectives by using a modified sampling train to implement the concept of exhaust-gas recirculation. Six field studies indicated that these techniques were practical and compared well with one another and with more labor-intensive approaches. Laboratory investigations with monodisperse aerosols indicated that commonly used geometries for sampling nozzles could cause a decrease in the particle size out of a closely coupled inertial sizing device. Nozzle geometries were also found which eliminated the observed shifts in particle size cut.

47952 (PB–89-194104/XAB) **Topical report on a field-monitoring study of homes with unvented gas space heaters. Volume 4. Quality assurance/control procedures and results. Final report, January 1985-June 1987.** Koontz, M.D.; Fortmann, R.C.; Nagda, N.L. GEOMET Technologies, Inc., Germantown, MD (USA). Nov 1988. 62p. (GEOMET-IE–1945). Available from NTIS, PC A04/MF A01.

See Volume 3, PB–88-216791.

During the period from January to March 1985, 157 residences in four Texas cities were monitored for pollutant concentrations and use of unvented gas space heaters (UVGSHs) and gas ranges. Average nitrogen dioxide (NO_2) and carbon monoxide (CO) concentrations and maximum/minimum indoor temperatures were monitored in all study homes. In selected homes, air-infiltration rates and time-varying pollutant concentrations were measured. Characteristics of structures, appliances, and occupants were collected through questionnaires and field-technician observations. Quality assurance and control procedures were developed and applied to endure that data of known and acceptable quality would be produced. Such procedures included an external audit, multipoint calibrations, zero and span checks, colocated samples, and other routine activities performed by field technicians.

47953 (PB–89-194229/XAB) **Estimating air-toxics emission from coal and oil combustion sources. Final report.** Brooks, G. Radian Corp., Research Triangle Park, NC (USA). Progress Center. Apr 1989. 448p. Available from NTIS, PC A19/MF A01.

To assist groups interested in inventorying air emissions of potentially toxic substances, EPA is preparing a series of documents that compiles available information on sources and emissions of toxic substances. The document deals specifically with methods to estimate air toxic emissions from coal and oil combustion sources. Its intended audience includes Federal, State, and local air pollution personnel and others interested in making estimates of toxic air pollutants emitted from coal and oil combustion sources.

47954 (PB–89-194252/XAB) **Development of the Regional Oxidant Model version 2.1. Interim report, January 1988-April 1989.** Young, J.O.; Aissa, M.; Boehm, T.L.; Coats, C.J.; Eichinger, J.R. Computer Sciences Corp., Research Triangle Park, NC (USA). May 1989. 64p. Available from NTIS, PC A04/MF A01.

This report describes improvements that were made to version 2.0 of the Regional Oxidant Model (ROM) in order to create version 2.1. The ROM is an Eulerian grid model that calculates hourly concentrations of ozone and other chemical species for episodes up to about a month long. The ROM's modeling domain, represented by a grid of cells that are approximately 19 km on a side, encompasses an area about 1000 by 1000 km. The physical processes that the ROM simulates include photochemistry, spatially- and temporally-varying wind fields, nocturnal jets and temperature inversions, terrain effects, dry deposition, and emissions of biogenic and anthropogenic ozone precursors. Major technical improvements include upgrading the Carbon Bond Mechanism to version 4.2, improving the biogenic emissions processor (which now includes a canopy model), updating the wind fields processor, and expanding the use of buoy data for determining meteorological data fields over water. Also, ROM 2.1 can be adapted more easily than version 2.0 to various modeling domains in eastern North America. In addition,

the computer software was redesigned to facilitate ROM's eventual application by outside users.

47955 (PB–89-195226/XAB) **Locating and estimating air-toxics emissions from municipal-waste combustors. Final report, August 1988-March 1989.** Epner, E.P.; Vancil, M.A. Radian Corp., Research Triangle Park, NC (USA). Apr 1989. 92p. Available from NTIS, PC A05/MF A01.

This document is intended to assist groups interested in inventorying air emissions of various potentially toxic substances from municipal-waste combustors. Its intended audience includes Federal, State, and local air pollution personnel. The document presents information on the process description of the various types of municipal-waste combustors and their air pollution control equipment. Emission factors are presented for each major type of municipal waste combustor for the following: acid gases including hydrogen chloride, hydrogen fluoride, and sulfur trioxide; metals including arsenics, beryllium, cadmium, chromium, mercury and nickel; and organics including chlorinated dibenzo-p-dicxins, dibenzofurans, polychlorinated biphenyls, formaldehyde, benzo(a)pyrene, chlorinated benzene, and chlorinated phenol.

47956 (PB–89-195903/XAB) **Walk-through survey report, Gulfstream American Corporation (formerly Grumman-American Aviation Corp.) Savannah, Georgia.** Matanoski, G.; Billings, C.; Levine, M.; Lees, P.; Zaebst, D. Johns Hopkins Univ., Baltimore, MD (USA). May 1979. 22p. Available from NTIS, PC A03/MF A01.

Portions of this document are not fully legible.

The four major paint shops (light aircraft, small parts, Colar anti-corrosive primer, and the Alodine epoxy/phenolic resin paint shop) employing 30 workers at Gulfstream American Corporation, Savannah, Georgia were the primary focus of a walk-through on July 12 and 13, 1978. The company's record-keeping system, medical program, and industrial-hygiene program were examined. The authors recommend that the light aircraft paint shop be included in an industrial hygiene study since the workload is fairly steady, types of paints and peripheral exposures are easily documented, and current control measures result in relatively low exposures of personnel to paint constituents. An epidemiological study is not recommended because the facility is new and the number of painters and the duration of exposures are limited. The authors suggest that this factory be considered during the final selection of aircraft manufacturing facilities for medical studies because of the degree of potential exposure to polyurethane paint.

47957 (PB–89-197388/XAB) **Feasibility report for a dispersion predictability model.** Lewellen, W.S.; Sykes, R.I.; Parker, S.F. National Science Foundation, Washington, DC (USA). Aug 1986. 39p. (ARAP–587). Available from NTIS, PC A03/MF A01.

This investigation demonstrated the feasibility of developing a practical model of the probability distribution function for environmental dispersion problems. Analysis of laboratory and atmospheric concentration fluctuations have shown that a two-parameter family of clipped normal distributions provides a reasonably accurate description of the concentration probability distribution function over a wide range of conditions. These two parameters are the expected mean value of concentration, c, and the expected root mean square variation of the concentration in ensemble space, sigma sub c. Preliminary analysis has also indicated that it will be possible to develop a straightforward set of ordinary differential equations to relate the spatial and temporal distribution of these two primary parameters to measurable ambient environmental conditions. The more completely the environmental conditions are defined, the lower this ratio should become, but practical limitations on monitoring instrumentation will almost always leave significant uncertainty.

47958 (PB–89-865091/XAB) **Asbestos removal. January 1970-June 1989 (Citations from the NTIS data base). Report for January 1970-June 1989.** National Technical Information Service, Springfield, VA (USA). Jul 1989. 70p. Available from NTISPC N01/MF N01.

Supersedes PB–88-866397.

This bibliography contains citations concerning methods of removing asbestos from buildings and water. Walk-through survey reports describe wet and dry removal techniques being employed at work sites. Containment barriers, ventilation systems, and vacuum systems used during asbestos-removal projects are also described. Monitors that measure asbestos dust fibers, and water filters that remove asbestos are also discussed. Alternative uses in highways and as an absorbing agent in oil-spill cleanups are explored along with disposal methods. (This updated bibliography contains 107 citations, 16 of which are new entries to the previous edition.)

5003 Radioactive Materials Monitoring and Transport

Refer also to citation(s) 47126, 47130, 47154, 47171, 47172, 47921, 47985, 48127

47959 (AERE-R–12362) **Studies of environmental radioactivity in Cumbria. Pt. 13. Measurements of carbon-14 in tree rings from trees growing in the Sellafield area.** Otlet, R.; Longley, H.; Walker, A.J. UKAEA Harwell Lab. (UK). Nuclear Physics and Instrumentation Div.; Department of the Environment, London (UK). Apr 1989. 35p. (DOE-RW–89.017). Available from H.M. Stationery Office, London, price Pound 10.25.

The main objective of the project was to reconstruct a chronology of past ^{14}C levels in atmospheric CO_2 in the vicinity of the Sellafield reprocessing plant by measuring the ^{14}C in individual tree rings from trees felled at a number of sites. The profile obtained from the results reflects the build up of the plant operations and related aerial emissions and a conversion of the tree ring records to past annual aerial discharges of ^{14}C has been attempted. This is compared with values provided from recent estimates of aerial emissions. The effect of dispersion along a coastal transect to a distance of 30km from BNFL Sellafield has also been studied. Comparable, but attenuated profiles to the inland sites are observed although the major peaks are not precisely mirrored along the transect. This is attributed to greater year to year variation due to sea breezes. (author).

47960 (INIS-mf–11515, pp. 55) **Comparison of hot particles in the Chernobyl fallout and in the nuclear weapons tests fallout.** Keck, G. (Veterinaermedizinische Univ., Inst. fuer Medizinische Physik, Vienna (Austria)); Cabaj, A. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47961 (JAERI-M–89-017) **Discussion on emergency aerial survey system for practical use. Survey technique, system, operation and management.** Moriuchi, Shigeru; Nagaoka, Toshi; Sakamoto, Ryuichi; Tsutsumi, Masahiro; Satio, Kimiaki; Amano, Hikaru; Matsunaga, Takeshi; Yanase, Nobuyuki; Kasai, Atsushi. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1989. 88p. (In Japanese). Order Number DE90701645/JAW. Available from NTIS (US Sales Only), PC A05/MF A01.

In 1980, after the occurrence of the TMI-2 accident in the United States, JAERI started the research and development of aerial survey techniques, and completed two prototype aerial survey systems in 1985 for gamma ray survey and for radioactivity monitoring. Following the Chernobyl reactor accident which occured in Soviet Union in 1986, European countries experienced environmental radiological monitoring using their aerial survey systems, and proved the effectiveness of aerial survey in the emergency. This report describes the outline of the prototype survey systems developed at JAERI, and showed the practical survey systems data processing, data analysis and the techniques including data processing, data analysis and the example outputs. Also, this report made some proposals concerning practical construction and the arrangement of the aerial survey equipments and the establishment of organization which takes charge of the practical emergency survey and the routine maintenance, based on our past experience. (author).

47962 (PB–89-173231/XAB) **Diagnostic approaches to better solutions of radon IAQ (indoor air quality) problems.** Harrje, D.T.; Hubbard, L.M. Princeton Univ., NJ (USA). 1988. 12p. Available from NTIS, PC A03/MF A01.

This paper discusses diagnostic approaches that offer improved evaluations of radon-related indoor air quality (IAQ) problems. An informed solution involves knowledge of the building, the building site, and the interaction of radon sources with the living space. The diagnostics can be viewed as having applicability in four phases of the mitigation process: (1) diagnostics which assess the radon problem; (2) premitigation diagnostics, from which a suitable mitigation approach must be chosen; (3) important diagnostics that check the performance of the radon mitigation solution; and (4) diagnostics that determine if the radon problem has been solved (that guideline values have not been exceeded over the different seasonal conditions experienced). A consensus of current knowledge on important radon diagnostic techniques and how they may be best applied are the result of a two-day Radon Diagnostics Workshop sponsored by the U.S. EPA held at Princeton University, April 13-14, 1987. This paper will summarizes those findings, placing the various radon diagnostic techniques in perspective.

47963 (PB–89-189419/XAB) **Radon measurements in schools: an interim report.** Office of Radiation Programs, Washington, DC (USA). Mar 1989. 39p. (EPA–520/1-89/010). Available from NTIS, PC A03/MF A01.

The report provides school officials, groups such as Parent-Teacher Associations, and other interested person with interim information on how to measure radon in schools and what to do if elevated levels are found. The first sections of the document contain facts about radon and the health risks associated with radon exposure. The next sections summarize what is known about radon in schools and provide guidance for conducting radon measurements. The last sections describe how to interpret the measurement results and suggest techniques that can be used to reduce radon concentrations if elevated levels are found.

47964 (PB–89-190136/XAB) **Central radon data base and digitized bedrock map of US EPA (Environmental Protection Agency) Region 1. Technical report.** Sears, E.B. Harvard Univ., Boston, MA (USA). School of Public Health. 1988. 12p. Available from NTIS, PC A03/MF A01.

This research entails compilation, management, and evaluation of existing data on domestic radon levels. The work requires the cooperation of radon programs throughout Region 1 states. The updated data base has geographic capabilities and can be used to gain a clearer picture of areas with high radon levels. The research for the report includes updating the radon data base for EPA's Region 1 and digitizing the existing Bedrock Geologic Map. Lifetime exposure to high indoor radon gas levels contributes to an increased risk of lung cancer. Geologic parameters are thought to be predictive factors of both well water and indoor radon levels. Therefore, because radon is an important environmental risk and because risk communication is likely to play a central role in EPA's policies for radon related risk, the project attempts to develop appropriate radon risk communication strategies.

47965 (PB–89-196422/XAB) **Communicating radon risk effectively: Radon testing in Maryland. Final report.** Desvousges, W.H.; Smith, V.K.; Rink, H.H. Research Triangle Inst., Research Triangle Park, NC (USA). Oct 1988. 158p. Available from NTIS, PC A08/MF A01.

Two sets of materials and corresponding delivery strategies for communicating radon risk were evaluated, compared with a 'no-special-treatment' strategy in a comparison community. One community received radio public-service announcements and utility bill inserts. The second received these plus posters, local government sponsorship of a radon awareness week, and local slide presentations. The most-intensive efforts (multiple channels, multiple hits) were more effective than the less intensive effort, which had little impact compared with no special treatment. From a marketing perspective, the effort was very successful, increasing the share of homeowners who tested for radon from 5% to 15%. This may not be viewed as sufficiently effective from a public-health perspective, however.

47966 (PB–89-203756/XAB) **Environmental Radiation Data: report 55, July-September 1988. Quarterly report.** Office of Radiation Programs, Washington, DC (USA). Mar 1989. 46p. (EPA–520/5-89/011). Available from NTIS, PC A03/MF A01.

See also PB–89-135958.

Environmental Radiation Data (ERD) contains data from the Environmental Radiation Ambients Monitoring System (ERAMS). Data from similar networks operated by contributing States, Canada, Mexico, and the Pan American Health Organization are reported in the ERD when available. The ERAMS is comprised of nationwide sampling stations that provide air, surface and drinking water and milk samples from which environmental radiation levels are derived. Sampling locations are selected to provide optimal population coverage while functioning to monitor fallout from nuclear devices and other forms of radioactive contamination of the environment. The radiation analyses performed on these samples include gross alpha and gross beta levels, gamma analyses for fission products, and specific analyses for uranium, plutonium, strontium, iodine, radium, krypton, and tritium.

5006 Regulations

Refer also to citation(s) 46841, 47232

47967 (PB–89-181259/XAB) **Materials Aerometric data base for use in developing materials damage functions.** Tang, R.T.; Barlow, P.M.; Waldruff, P. Computer Sciences Corp., Research Triangle Park, NC (USA). Apr 1989. 29p. Available from NTIS, PC A03/MF A01.

Meteorological and air-quality data acquired at field-exposure sites have been accumulated into the Materials Aerometric Database (MAD). The National Acid Precipitation Assessment Program (NAPAP) will use the MAD to develop damage functions for materials exposed at the sites; these functions then will be used in preparing NAPAP integrated assessment reports to Congress. The MAD data cover as many as six and a half years at five materials exposure sites in the eastern United States. Conservative techniques based on secondary-site data, regression predictions, and other information have been applied to the MAD to enhance the quality and usability of the data base.

47968 (PB–89-190144/XAB) **Federal policy options for indoor air pollution from combustion appliances. Technical report.** Kandarjian, L. California Univ., Los Angeles, CA (USA). School of Public Affairs. 1988. 16p. Available from NTIS, PC A03/MF A01.

In fiscal year 1988 the Environmental Protection Agency spent approximately 260 million dollars to reduce the levels of pollutants in the outdoor atmosphere. For reduction of indoor pollutants, it spent only three million dollars. The average person spends over 90% of their time indoors, and for many contaminants, indoor concentrations exceed outdoor levels. Thus, indoor pollutants may pose a greater threat to humans than outdoor pollutants. Energy-conservation measures that result in tighter building envelopes and reduced rates of outdoor ventilation tend to increase the concentration levels of indoor contaminant levels. Typical indoor pollutants include radon, formaldehyde, volatile organic compounds, particles, biological contaminants, and combustion gases. The paper focuses on gas stoves, unvented gas space heaters, woodburning stoves, and kerosene heaters as representative combustion sources. The first section discusses these sources, the health problems they pose, and physical control mechanisms to reduce indoor pollutant concentrations. The second section examines the federal policy options for indoor air pollution; summarizes the available federal, state, and local legislative authorities; defines regulatory and non-regulatory approaches to mitigate indoor air pollution; and presents possible federal actions for controlling combustion-source pollutants.

47969 (PB–89-198816/XAB) **Flexible Regional Emissions Data System (FREDS) documentation for the 1985 NAPAP (National Acid Precipitation Assessment Program) emissions inventory. Final report.** Modica, L.G.; Dulleba, D.R.; Walters, R.A.; Langstaff, J.E. Alliance Technologies Corp., Bedford, MA (USA). May 1989. 577p. (TRC-A–87-342). Available from NTIS, PC A25/MF A01.

See also PB–88-129499. Portions of this document are not fully legible.

This report documents the Flexible Regional Emissions Data System (FREDS) for the 1985 NAPAP Emissions Inventory. FREDS extracts emissions data, modeling parameters (e.g., stack height,

exhaust gas temperature), and source identification information from point/area source NEDS data, and applies temporal, spatial, and pollutant species allocation factors to derive a gridded, speciated, and temporally resolved emissions file for input to regional-scale atmospheric simulation models (e.g., the Regional Acid Deposition Model and Regional Oxidant Model). FREDS consists of seven modules that reformat the data, apply allocation factors to the annual emissions data, and ensure the quality of FREDS output. In addition to FREDS, peripheral software is used to maintain the allocation factor files. Separate programs are used to process point/area sources. The seven modules are the Hydrocarbon Preprocessor, the Quality Control Module, the Model Data Extraction Module, the Temporal Allocation Module, the Speciation Module, the Spatial Allocation Module, and the Model Input Preprocessor. Many of the modules can be implemented in a logical sequence or independently of the others in most cases. For maximum flexibility, FREDS allows the user to define and assign emissions of up to 15 pollutants prior to speciation, the temporal scenario, and other variables.

47970 (PB–89-204762/XAB) **Superfund Record of Decision (EPA Region 3): Palmerton Zinc Pile, Pennsylvania (second remedial action), September 1988.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 May 1988. 64p. (EPA/ROD/R–03-88/063). Available from NTIS, PC A04/MF A01.

The Palmerton Zinc site is composed of two locations in the Borough of Palmerton, Carbon County, Pennsylvania. Smelting operations were conducted in the west plant from 1898 to 1987, and in the east plant from 1911 to present. Primary smelting of concentrated zinc sulfide ores, conducted until December 1980, resulted in the emission of large quantities of zinc, lead, cadmium, and sulfer dioxide. This air pollution caused defoliation of over 2,000 acres of vegetation in the vicinity of the east smelter. Between 1898 and 1987 process residue and other plant wastes were disposed of on Cinder Bank, a 2.5-mile, 2,000-acre waste pile. The selected remedial action for the site includes: slope modification, capping, and application of a vegetative cover on Cinder Bank; construction of surface water diversion channels; surface water and leachate collection and treatment using lime-activated filtration lagoons and/or constructed wetlands; implementation of an inspection, monitoring, and maintenance plan; and wetlands restoration measures, if necessary.

51 ENVIRONMENTAL SCIENCES, TERRESTRIAL

5101 Basic Studies

47971 (ANSTO/E–669) **Error introduced into a water density measurement due to the presence of a water density gradient.** Wilson, D.J. Australian Nuclear Science and Technology Organisation, Lucas Heights (Australia). Aug 1988. 49p. Order Number DE90601282/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

A multigroup diffusion code has been used to calculate the thermal neutron flux resulting from a neutron source in a homogeneous soil system in which there is a linear water density gradient. A relative neutron count rate is obtained by integrating the thermal flux over the volumes of different detectors in that flux. By repeating the calculation in the same soil system containing water at a constant density equal to that pertaining to the measuring point in the gradient system, the change in flux due to the gradient can be determined. The magnitude of the effect is mainly a function of the soil density, the slope of the water density gradient, the proximity of the gradient to the detector and the water density. The mass absorption coefficient and the mass scattering coefficient have very little influence on this effect.

47972 (DOE/ER/60242–T1) **Landscape dynamics in the Arctic foothills: Progress report, July 1, 1988–August 31, 1989.** Walker, D.A.; Walker, M.D.; Lederer, N.D. Colorado Univ., Boulder, CO (USA). Inst. of Arctic and Alpine Research. 31 Aug 1989. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER60242. Order Number DE89016544/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This document contains a summary of research accomplished by the University of Colorado's Institute of Arctic and Alpine Research (INSTAAR) Joint Facility for Regional Ecosystem Analysis (JFREA) for the Department of Energy's R4D research program. Field surveys for a set of orthophoto maps and digital terrain models at the Toolik Lake site were completed. The Arctic LTER site has provided $25,000 to obtain aerial photographs and develop the base maps. During the 1989 summer field season, vegetation surveys were completed at the Toolik Lake site in preparation for geobotanical mapping in 1990. Point quadrat samples, biomass samples, and soil samples were collected from 80 plots located at the Toolik Upland dust study site. The samples were collected along 8 transects parallel to the road at 5, 10, 25, 50, 100, 200, 400, and 800 m from the road. Permanently-located point quadrat samples and soils were collected from 88 points on the Benson Grid that are also contained on the 1:500-scale vegetation map. This information will be used as baseline information for planned disturbance studies at the site and to the examine the changes in vegetation with respect to terrain morphology and other GIS variables.

47973 (DOE/ER/60242–T2) **Wetland soils and vegetation, Arctic Foothills, Alaska.** Walker, M.D.; Walker, D.A.; Everett, K.R. Walker Geobotanical Surveys, Lafayette, CO (USA). Jun 1989. 89p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-84ER60242. (BR–89(7)). Order Number DE89016600/JAW. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This report is one of a series sponsored by the FWS to examine relationships between wetland plants and soils in a variety of habitats. It examines a first order watershed in the Arctic Foothills of the Brooks Range, northern Alaska, which is representative of similarly aged surfaces in the foothills region. Its major purpose is to determine if soils meeting the Soil Conservation Service (SCS) definition of "hydric" support wetland plant species.

47974 (ORNL/FTR–2823) **[Visit to the La Selva Biological Station, Costa Rica]: Foreign trip report, February 28–March 5, 1988.** Reichle, D.E. Oak Ridge National Lab., TN (USA). 17 Mar 1988. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017377/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler attended the quarterly meeting of the National Board of Governors of The Nature Conservancy held in Costa Rica to highlight their international program in Central America. The traveler used this opportunity to visit the La Selva Biological Station of the Organization for Tropical Studies and to examine their ecosystem research project on wet lowland tropical forests. Discussions were held with the co-directors, faculty, students, and visiting scientists from the United States.

47975 (ORNL/FTR–2866) **[Effects of nutrient recycling and food chain length on resilience]: Foreign trip report, April 3–30, 1988.** DeAngelis, D.L. Oak Ridge National Lab., TN (USA). 11 May 1988. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017403/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler was a Guest Scholar in the Department of Biophysics at Kyoto University during the first three weeks of April 1988 at the invitation of Professor Ei Teramoto, Dean of the Faculty of Sciences. First, the traveler attended the Annual Meeting of the Japanese Ecological Society (JES) at Tohuku University, Sendai, where he presented a paper at a special symposium on theoretical ecology. Following the JES meeting, the traveler returned to Kyoto University to exchange ideas on some theoretical problems in ecology related to ongoing work at ORNL, as well as to plan the details of the Joint US-Japan Seminar in the Environmental Sciences held in Honolulu later in April. The traveler presented a seminar on stream nutrient cycling research being conducted at ORNL. The Joint US-Japan Seminar in the Environmental Sciences took place during the final week of April. The traveler was the US organizer of the meeting, and Professor Teramoto was the Japanese organizer. In attendance where 11 invited US and 15 invited Japanese ecologists and mathematical modelers, along with several observers from the University of Hawaii. The meeting was successful in promoting a strong

interchange of ideas between US and Japanese scientists and promoting a synthesis of work in different areas of ecological theory.

47976 (ORNL/FTR–3153) **[SCOPE workshop on Landscape boundaries: Consequences for biotic diversity and ecological flows]: Foreign trip report, December 12–15, 1988.** Gardner, R.H. Oak Ridge National Lab., TN (USA). 29 Dec 1988. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017368/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report describes the foreign travel of R.H. Gardner of the Environmental Sciences Division (ESD), Oak Ridge National Laboratory (ORNL), who attended the Scientific Committee on Problems of the Environment (SCOPE) workshop, "Landscape Boundaries: Consequences for Biotic Diversity and Ecological Flows," at the SCOPE headquarters in Paris, France. R.H. Gardner was invited by SCOPE, which paid expenses excluding salary, to participate in the presentation and discussion of the theoretical and empirical evidence of boundary effects on ecosystem dynamics. Ecotones, the transition zones between landscape elements, appear important in mediating the structure and functioning of ecological systems. The participants of the workshop represented a diverse array of scientists; they were invited to synthesize existing information, formulate theory, and develop management strategies. The Paris meeting concentrated on the theoretical and empirical means of measuring ecotone effects and the possible climate-mediated change in the structure and functioning of ecotones.

5102 Chemicals Monitoring and Transport

Refer also to citation(s) 46990, 47479, 47862, 48017, 48018, 48021, 48035, 48155

47977 (AD-A–207707/1/XAB) **Ox Mountain sanitary landfill: Apanolio Canyon expansion site, San Mateo County, California. Volume 2. Appendix. Final report.** Harding-Lawson Associates, Novato, CA (USA). Apr 1989. 414p. Available from NTIS, PC A18/MF A01.

See also Volume 1, AD-A207-706.

Further studies include: plants Observed in Apanolio Canyon; Animals Expected or Observed in Apanolio Canyon; Marbled Murrelet Survey; Review of Available Scientific Information on Six Candidate Insects; Update on Status of Candidate Insects; Apanolio Canyon Sensitive Plant Investigation; Fisheries Resources of Upper Apanolio, Benthic Invertebrate Survey of Apanolio, Corinda Los Trancos, and Pilarcitos Creeks, San Mateo County, California; Streamflows and Velocity of Flows at the Bongard diversion Dam in Apanolio Canyon; A Spring Survey to Determine the Presence or Absence of the San Francisco Garter Snake (Thamnophis sirtalis tetrataenis) in Two Tributaries of Pilarcitos Creek, Half Moon Bay, CA; Wildlife and Fisheries Mitigation Plan, Ox Mountain Sanitary Landfill, Apanolio Canyon Expansion Site; Correspondence Site Selection Criteria Information; Draft Contingency Remedial Action Plan; Leachate Collection and Removal System (LCRS) and Leachate/Contaminated Groundwater Treatment Systems; Apanolio Creek Streamflow Augmentation Plan; Apanolio Canyon Lower Aquifer Recharge Plan; Application for Exemptions - Technical Informations; Geotechnical Study and Specifications, Subgrade Barrier and Clay Liner System; Apanolio Canyon Boring Logs; Potentiometric Surface Maps, Apanolio Canyon; Geologic Cross Sections - Apanolio Canyon; Interim Report on Leachate Exposure Test Program, Apanolio Canyon Landfill Expansion.

47978 (CONF-881054–Vol.3, pp. 709-720) **Laboratory studies to support microbially mediated in situ soil remediation.** Arthur, M.F. (Battelle Columbus Div., OH (USA)); Zwick, T.C.; O'Brien, G.K.; Hoeppel, R.E. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 3.* Order Number DE89014702/JAW. Available from NTIS, PC A14/MF A01.

The objective of this laboratory study was to evaluate the effectiveness of hydrogen peroxide (H_2O_2) versus forced air (FA) for stimulating bioremediation of fuel-contaminated soils. Soil 1 was heavily contaminated, soil 2 was less contaminated, and soil was an uncontaminated background soil. The soils were set up in 18 soil columns that were 39 inches in depth, and 12 inches in diameter. Duplicate columns of the three soils received either 400 ppm H_2O_2, FA, or no supplemental aeration (control). The soils were also supplemented with inorganic nutrients and the pH was adjusted to nearly neutral. Parameters monitored periodically through six months of aeration included oxidation/reduction potential (Eh), dissolved oxygen (DO), acetone-extractable hydrocarbons by flame ionization detection gas chromatography (FID/GC), nutrient agar-platable aerobic bacteria, and hydrocarbon-degrading bacteria. All three soils contained numerous hydrocarbon-degrading bacteria. A definite advantage of H_2O_2 over FA for stimulating biodegradation in the contaminated soils (soils 1 and 2) was not observed. Neither Eh nor DO levels were substantially improved by H_2O_2 compared to FA. In soils 1 and 2, a loss of total extractable hydrocarbons was observed through time in both H_2O_2 and FA treatments. This may have been the result of soil venting, enhanced microbial activity, or a combination of venting and microbial activity. In some cases, a temporary increase in microbial numbers over initial levels was seen as a result of H_2O_2 and FA treatments.

47979 (CONF-881054–Vol.3, pp. 721-732) **In situ immobilization of PCBs at Pepper's Steel and Alloys site establishes a precedent as permanent remedy for nonvolatile organics.** Dole, L.R. (Florida Power and Light Co. (USA)). Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 3.* Order Number DE89014702/JAW. Available from NTIS, PC A14/MF A01.

This study establishes the feasibility and the performance characteristics of the on-site, in situ immobilization technology used for the remediation of the 120,000 cubic yards of heavy metal and PCB-contaminated, transformer-oil soaked soils at the Pepper's Steel and Alloys (PSA) Superfund site in Medley, Florida (N.W. Miami). Until its June 1988 remediation, the PSA site was on the National Priorities List (NPL). This 30-acre site, used for a junk yard and scrap recovery operation, had used transformers purchases from the Florida Power and Light Company (FPL). Subsequently, FPL became the major deep-pocket principal responsible party. The PCB-oil and heavy metal contamination on the site extended from 2 to 8 feet into the soils and into the Biscayne aquifer that is the sole source of drinking water for Miami metropolitan area. This site is upgradient within 6 miles of Miami's well fields. With full disclosure to EPA Region IV, FPL planned and conducted a formulation, testing, and modeling program that demonstrated the safety of the monolithic grout formula poured directly into this critical regional aquifer.

47980 (CONF-881054–Vol.3, pp. 733-744) **Soil cleanup by in situ surfactant flushing. I. Mathematical modeling and lab scale results.** Wilson, D.J. (Vanderbilt Univ., Nashville, TN (USA)); Clarke, A.N. Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA); Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 3.* Order Number DE89014702/JAW. Available from NTIS, PC A14/MF A01.

Mathematical models for in situ surfactant flushing of hydrophobic organic compounds from soil and aquifers and for flushing of samples in laboratory columns are described. These models assume local equilibrium between the hydrophobic contaminant adsorbed or present as liquid or solid, and contaminant solubilized in surfactant micelles in the mobile phase. The equilibrium expression permits the inclusion of contaminant adsorption on the substrate. Fluid velocity fields in the vicinity of the surfactant injection and recovery wells are calculated from the solutions to Laplace's equation satisfying appropriate boundary conditions and having suitably located sources and sinks. These velocity fields are then used in the mass balance equations for the volume elements into which the region of interest is partitioned, and these equations are integrated forward in time numerically. Results showing the effects of the model parameters are presented, and the effects of a surrounding slurry wall on the flow lines of the surfactant solution are investigated. Data on the solubilization of model compounds (biphenyl, naphthalene, and p-dichlorobenzene) in sodium dodecylsulfate solutions are given; increases in solubility of more than 30-fold are readily achieved.

Elution curves for the flushing of the model compounds from spiked fine sand and from two spiked clay soils are given. Solvent extraction of the model compounds from loaded surfactant solution eluate is described; reclaimed surfactant is effective in solubilizing the model compounds. Lastly, a mathematical model for the solubilization process is presented. The relationship between this work and the earlier studies of Ellis, Payne, and McNabb and of Nash is discussed.

47981 (CONF-881054–Vol.4, pp. 1043-1054) **The applicability of investigative techniques at an abandoned landfill.** Reynolds, M.D. (E. C. Jordan Co., Oak Ridge, TN (USA)); Lyons, C.P. Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

A case history is presented which reviews the success of several techniques and approaches for remedial investigations. The purpose of the investigation was to support screening and evaluation of technologies to remediate contamination derived from an abandoned landfill. Due to the large area (approximately 18 acres) and uncontrolled usage history of the landfill, remote sensing techniques were chosen as the primary technique for source characterization. Intrusive techniques were used only in limited areas to gain insight into the disposal practices or to confirm remote sensing data. Exploration of contaminant migration pathways was conducted using traditional techniques (e.g., monitoring wells). However, costs of characterizing the fractured bedrock aquifer beneath the landfill were minimized by packer testing and modifying existing borings, and by careful testing of new borings prior to monitoring well installation. Geophysical investigations using a magnetometer were effective for source area characterization while soil gas sampling was less effective. Careful selection and testing of borings proved to be effective in identifying contaminant distribution and migration potential in groundwater.

47982 (CONF-881054–Vol.4, pp. 1055-1066) **Technological issues in Y-12 plant RCRA land unit closures.** Siberell, J.K. (Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA)). Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

Closures have been initiated or completed for eight land-based RCRA hazardous waste management units at the Oak Ridge Y-12 Plant, as part of the Closures and Post-Closures Activities (CAPCA) Project. At some of the sites, removal of contaminated sediments has been necessary, prior to final closure. Sediment removal has been accomplished, in part, by the use of a commercial Guzzler and modified back-hoe. At all but one of the sites, a multi-layer final cap is to be installed. The cap consists of a compacted clay layer, PVC membrane, drainage net, geotextile fabric, and vegetative cover layer. The cover is designed to minimize moisture infiltration, and was analyzed with the HELP computer model. Three sites (S-3 Pond, New Hope Pond, and Oil Retention Ponds) require structural stabilization of sediments, following removal of standing liquid, and prior to placement of the final cap. This presentation reviews the progress at each of the eight closure sites, and discusses technological issues encountered at each.

47983 (CONF-881054–Vol.4, pp. 1067-1078) **Field evaluation of a soil-gas analysis method for detection of subsurface petroleum hydrocarbon contamination.** Diem, D.A. (URS Corp., Sacramento, CA (USA)); Ross, B.E.; Kerfoot, H.B. Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

Evaluation of a new field technique of soil-gas measurement for delineation of subsurface petroleum hydrocarbon contamination is described. CO_2 soil-gas samples were collected from four sites at a military installation in Texas. The soil-gas survey served as the initial phase of an overall site characterization program that ultimately included borehole and monitoring well installation. CO_2 concentrations in soil gas were correlated with petroleum hydrocarbons found in soil and groundwater samples. It appears that the high concentrations of CO_2 measured at the sites were a result of contamination from heavier hydrocarbons such as motor oil and diesel fuel. This technique allows initial field screening of areas contaminated by hydrocarbons that have proven hard to detect using traditional soil-gas analysis methods.

47984 (CONF-881054–Vol.4, pp. 1299-1308) **Use of quantitative risk assessment and risk management in a facility siting issue at Randolph Air Force Base.** Smith, D.M. (NUS Corp., Pittsburgh, PA (USA)); Patarcity, J.M. Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

Quantitative risk assessment (QRA) techniques were employed to guide decision makers on the advisability of constructing a health maintenance facility on a site which had been previously employed for the handling of potentially hazardous chemical compounds. A site investigation study provided information regarding the occurrence and distribution of chemical compounds in soils and groundwater at the proposed facility site. Exposure potential was considered by determining the most likely pathways of chemical release and transport, as well as human activities at and near the site. Estimates of individual exposure and dose models were prepared for many different scenarios. Critical scenarios included: inhalation of contaminated soil particles by onsite workers during site construction activities; direct dermal contact with contaminated soils and concurrent accidental ingestion of contaminated soils by children during site occupancy. A contaminant release and transport model was used to estimate exposure to airborne particulates during construction activities.

47985 (DOE/OR/21400–T392) **Research organization: Environmental Sciences Division, Oak Ridge National Laboratory.** Reichle, D.E. Oak Ridge National Lab., TN (USA). Jan 1989. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017325/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Environmental Sciences Division (ESD) at Oak Ridge National Laboratory (ORNL) is a multidisciplinary research and development organization with a staff of over 200, plus nearly 180 visiting professional collaborators and students, occupying a complex of six major laboratory and office buildings. The Division's unique role is the development of fundamental scientific knowledge and the application of this knowledge to the solution of complex, long-term, and large-scale environmental problems of national importance. These problems are addressed by interdisciplinary teams of technical specialists from the fields of atmospheric chemistry, aquatic and terrestrial ecology, earth sciences, and geohydrology. A unique combination of basic and applied research, environmental assessment, and demonstration projects on the 550-ha Oak Ridge National Environmental Research Park makes the Division one of the nation's largest and most respected environmental research organizations. The Division conducts research on the environmental aspects of existing and emerging energy systems and applies this information to ensure that technology development and energy use are consistent with national environmental goals. ESD performs basic and applied research, environmental assessments, environmental engineering and demonstration projects, technology and operational support functions, and program management for the US Department of Energy (DOE), other federal and state agencies, and industry, working collaboratively with a number of federal agencies, universities, and the private sector in accomplishing its objectives.

47986 (UCID–21676) **A review of GEOTOX for the EPA multi-media assessment project.** McKone, T.E. Lawrence Livermore National Lab., CA (USA). May 1989. 24p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE89016716/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

GEOTOX is a set of programs used to calculate time-varying chemical concentrations in multiple environmental media (e.g., soil, ground water, etc.) and to estimate potential human exposures. The current version of GEOTOX performs two major tasks: (1) it predicts the transport and transformation of chemicals in a multimedia environment, and (2) it estimates human exposure. The chemical

transport model uses landscape data and physicochemical properties to determine the distribution and concentration of chemicals among compartments such as air, water, and soil. Environmental concentrations are linked to human exposures and health effects using an exposure model that accounts for intake through inhalation, consumption of food and water, and dermal absorption. GEOTOX is intended for use in public health and environmental risk assessment and risk management – particularly for the screening and ranking of chemicals according to the potential risks they pose. GEOTOX was originally developed for ranking the potential health risks associated with toxic metals and radionuclides in the global environment. The model has been extended to handle organic chemicals. GEOTOX was originally implemented on mainframe systems. Because of this, most of the input must be entered in fixed-format data files. However, comments have been added to the input files to make this format easy to use.

5103 Radioactive Materials Monitoring and Transport

Refer also to citation(s) 47130, 47143, 47966, 47985

47987 (AERE-R–13255(ed.2)) **Matrix diffusion user guide (release 2).** Herbert, A.W.; Preece, T.E. UKAEA Harwell Lab. (UK). Theoretical Physics Div. Apr 1989. 63p. Order Number DE90601274/JAW. Available from NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS.

This report presents an introduction to the use of the matrix diffusion option of the finite-element package NAMMU. The facilities available in the package are described; and the process of preparing the necessary input data is illustrated with an example. The matrix diffusion option of NAMMU models the transport of radionuclides in groundwater in a flow field governed by Darcy's Law. A detailed description of the mathematical model used for this option is given. The package uses the finite-element method. This allows the easy modelling of complex geological structures. (author).

47988 (AERE-R–13389) **Uptake of radiocaesium by upland herbaceous vegetation in relation to soil type.** Sandalls, F.J.; Eggleton, A.E.J.; Gaudern, S.L. UKAEA Harwell Lab. (UK). Environmental and Medical Science Div. Feb 1989. 46p. Available from H.M. Stationery Office, London, price Pound 8.00.

Between April 1987 and November 1988, the uptake of radiocaesium by herbaceous vegetation growing on a variety of upland soils contaminated in May 1986 by Chernobyl fallout was measured and found to be related to soil type, with the uptake on peat being an order of magnitude greater than on acid brown earth. The levels of radiocaesium in all the soils reflected both pre-Chernobyl and Chernobyl deposition, but levels in vegetation arose almost entirely from the Chernobyl material. Soil profiles showed all the radiocaesium to be within the rooting zone of the vegetation but uptake of Chernobyl radiocaesium was up to an order of magnitude greater than that of the weapons derived radiocaesium deposited 20-30 years earlier. The rate of uptake of the Chernobyl radiocaesium is therefore also expected to decrease with time. The levels of radiocaesium in the vegetation varied according to the time of year. The soil-to-plant transfer factors showed good correlations with organic matter content of soils, exchangeable caesium-134, exchangeable potassium and potassium in soil water at field capacity. The findings appear to offer scope for a significant reduction of radiocaesium uptake on these soils by way of soil amendment.

47989 (CONF-881054–Vol.4, pp. 1127-1138) **The determination of bioaccumulation in edible species from radioactive contamination at the Weldon Spring Site, St. Charles, Missouri.** Hoffman, R.L. (Jacobs Engineering Group, Inc., St. Charles, MO (USA)); Lusk, M. Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

A biological sampling program was developed in order to determine and characterize the level of potential human exposure to radionuclides from consumption of edible biota. Habitats included land areas contaminated with uranium in soil to concentrations of about 20 pCi/g and offsite water bodies contaminated to concentrations of 30 pCi/L. Fish populations sampled included bottom feeders such as catfish as well as pelagic species such as bass and sunfish. Terrestrial mammals included rabbits and squirrels only. Samples were prepared to represent edible portions only. Special analytical provisions were made to reduce the lower limit of detection of radionuclides in tissue to the range 0.01 to 0.05 pCi/g (wet weight). Of the approximately 30 composite samples analyzed (representing over 100 animals), all exhibited levels below detection limits. A comparison with other bioaccumulation factors from the literature is given. The upper bound to bioaccumulation factors resulting from this study indicate levels an order of magnitude less than modeled values but are in agreement with measured factors for similar organisms.

47990 (CONF-881054–Vol.4, pp. 1141-1152) **Environmental monitoring at the US Department of Energy's Hanford Site, Washington.** Gray, R.H. (Pacific Northwest Lab., Richland, WA (USA)). Analysas Corp., Oak Ridge, TN (USA). 1988. DOE Contract AC06-76RL01830. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

Environmental monitoring has been an ongoing activity on the US Department of Energy's Hanford Site in southeastern Washington for over 40 years. Objectives are to detect and assess potential impacts of site operations on air, surface and ground water, foodstuffs, fish, wildlife, soil and vegetation. Data from monitoring efforts are used to calculate the overall radiological dose to humans working onsite or residing in nearby communities. In 1987, measured Hanford Site perimeter concentrations of airborne radionuclides were below applicable DOE and Environmental Protection Agency guidelines. Tritium and nitrate continued to be the most widespread constituents in sonite ground water. Chromium, cyanide, fluoride, and carbon tetrachloride were found in ground-water wells near operating areas. Concentrations of radionuclides and nonradiological water quality in the Columbia River were in compliance with applicable standards. Foodstuffs irrigated with river water taken downstream of the Site showed low levels of radionuclides that were similar to concentrations found in foodstuffs from control areas not irrigated with Columbia River water. Low levels of ^{90}Sr and ^{137}Cs in some onsite wildlife samples were typical of those attributable to worldwide fallout as were concentrations of radionuclides found in soils and vegetation from onsite and offsite locations. The calculated dose potentially received by a maximally exposed individual (i.e., a hypothetical individual using worst-case assumptions for all routes of exposure) in 1987 (0.05 mrem/yr) was similar to that calculated for 1985 and 1986. Measured exposure to penetrating radiation and calculated radiation doses to the public were well below applicable regulatory limits.

47991 (DOE-RW–88.103) **Measurement of radioactivity from Chernobyl in population groups in Scotland.** East, B.W.; Robertson, I. Department of the Environment, London (UK). Mar 1989. 61p. Order Number DE90601353/JAW. Available from NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS.

The results of a survey of the uptake of radiocaesium by members of the Scottish population between May 1986 and February 1988 following the Chernobyl reactor accident are described. 251 volunteers from various parts of the country were measured by high sensitivity whole-body monitoring and 487 observations are reported. Influence of age, sex, diet and geographical location on uptake was assessed. All members of the Scottish population have almost certainly taken up some radiocaesium as a result of the accident. Body levels reached a maximum after about 8 months and varied by a factor of 4 from an upper to a lower boundary covering 80% of the population sampled. Total (^{134}Cs + ^{137}Cs) mean dose equivalents from the observations were 31μSv and 20μSv for the first and second years and 62μSv for the overall dose commitment based on the observed decline of radiocaesium. Fresh milk consumption appeared to be the most important dietary factor influencing body levels and venison and goat-meat eaters formed a special group with significantly higher levels than the rest of the population.

47992 (INIS-mf–11515, pp. 55) **Vertical distribution of the Chernobyl fallout in snow profiles.** Ambach, W. (Innsbruck Univ.

(Austria). Inst. fuer Medizinische Physik); Blumthaler, M.; Rehwald, W.; Brunner, P.; Eisner, H. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194--: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society*. Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

47993 (JAERI-M--89-011) **Migration of multiradionuclides in sandy soil layer at different acidityes.** Takebe, Shinichi; Yamamoto, Tadatoshi. Japan Atomic Energy Research Inst., Tokyo (Japan). Feb 1989. 21p. (In Japanese). Order Number DE90701622/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

The migration characteristics of multinuclides in a sandy soil layer were examined with an aerated soil layer mode apparatus under acidic, neutral and alkaline inflow conditions. The effluent ratios of each radionuclide were small under acidic and neutral condition, but large under alkaline condition. The migration of each radionuclide obtained were as follows: (1) In acidic condition, the adsorption ratio of ^{137}Cs in vertical direction of the sand layer decreased exponentially from the surface of sand layer, and more slowly with increase in the depth of the sand layer. However, ^{60}Co and ^{85}Sr were observed a peak of adsorption distribution at the distance of several centimeters from the surface. (2) In neutral condition, three radionuclides were all similar in the adsorption distribution. (3) In alkaline condition, the migration of each radionuclide was the same as that in neutral condition. Relationships between pH of inflow solution and migration velocity of radionuclide were further examined and some results were obtained: The migration velocity of ^{85}Sr varied with pH, which corresponded to the variation of distribution coefficient (Kd) with pH, on the basis of ion exchange reaction. The migration velocity of ^{60}Co and ^{137}Cs at low concentration was very large under alkaline condition. (author).

47994 (ORNL/FTR--3132) **[Biospheric Model Validation Study (BIOMOVS) and the revision of IAEA safety series No. 57]: Foreign trip report, November 7--23, 1988.** Hoffman, F.O. Oak Ridge National Lab., TN (USA). 6 Dec 1988. 39p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE89017364/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The Seventh Workshop of the Biospheric Model Validation Study (BIOMOVS), held at the Japan Atomic Energy Research Institute (JAERI) at Tokai, was attended by Dr. F.O. Hoffman from ORNL. BIOMOVS is an international cooperative effort to test models designed for calculating environmental transfer and bioaccumulation of radionuclides and other trace substances. The purpose of the workshop was to compare model predictions with independent data sets. Comprehensive data from the Chernobyl accident for thirteen sites have been provided for model testing.

47995 (ORNL/RASA--88/38) **Results of the radiological survey at 9 Redstone Lane, Lodi, New Jersey (LJ069).** Foley, R.D.; Carrier, R.F. Oak Ridge National Lab., TN (USA). Jul 1989. 11p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE89016468/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process waste and residues associated with the production and refining of thorium and thorium compounds from monozite ores from 1916 to 1956. MCW supplied rare earth metals and thorium compounds to the Atomic Energy Commission and various other government agencies from the late 1940s to the mid-1950s. Areas residents used the sandlike waste from this thorium extraction process mixed with teas and cocoa leaves as mulch in their yards. Some of these contaminated wastes were also eroded from the site into Lodi Brook. At the request of the US Department of Energy (DOE), a group from Oak Ridge National Laboratory conducts investigate radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally ^{232}Th, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, 9 Redstone Lane, Lodi, New Jersey (LJ069), was conducted during 1987. Measurements at the private property located at 9 Redstone Lane indicate slightly elevated gamma exposure rates in association with cinder-like material observed in logging holes. These elevated levels result from naturally occurring radioactivity present in such substances as ashes and cinders. They are not related to the deposit of residues from processing operations at the MCW site. All other radiological findings conform to the guidelines established by the DOE for the Maywood, New Jersey, area remedial action plan. 4 refs., 3 figs., 3 tabs.

47996 (ORNL/RASA--88/40) **Results of the radiological survey at 205 Main Street, Lodi, New Jersey (LJ075).** Foley, R.D.; Carrier, R.F.; Floyd, L.M.; Crutcher, J.W. Oak Ridge National Lab., TN (USA). Aug 1989. 31p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE89016792/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. MCW supplied rare earth metals and thorium compounds to the Atomic Energy Commission and various other government agencies from the late 1940s to the mid-1950s. Area residents used the sandlike waste from this thorium extraction process mixed with tea and cocoa leaves as mulch in their yards. Some of these contaminated wastes were also eroded from the site into Lodi Brook. At the request of the US Department of Energy (DOE), a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally ^{232}Th, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, 205 Main Street, Lodi, New Jersey (LJ075), was conducted during 1987 and 1988. Results of the survey indicated radioactivity in the range of normal background for the northern New Jersey area. Radiological assessments of soil samples from the site demonstrate no radionuclide concentrations in excess of DOE Formerly Utilized Sites Remedial Action Program criteria. 5 refs., 21 figs., 3 tabs.

47997 (ORNL/RASA--88/80) **Results of the radiological survey at 88 East Central Avenue, Maywood, New Jersey (MJ037).** Foley, R.D.; Crutcher, J.W. Oak Ridge National Lab., TN (USA). Jun 1989. 15p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE89017339/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. MCW supplied rare earth metals and thorium compounds to the Atomic Energy Commission and various other government agencies from the late 1940s to the mid-1950s. Area residents used the sandlike waste from this thorium extraction process mixed with tea and cocoa leaves as mulch in their yards. Some of these contaminated wastes were also eroded from the site into Lodi Brook. At the request of the US Department of Energy (DOE), a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally ^{232}Th, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, 88 East Central Avenue Maywood, New Jersey (MJ037), was conducted during 1988. Results of the survey indicated radioactivity in the range of normal background for the northern New Jersey area. Radiological assessments of soil samples from the site demonstrate no radionuclide concentrations in excess of DOE Formerly Utilized Sites Remedial Action Program criteria. 4 refs., 2 figs., 3 tabs.

47998 (ORNL/RASA--88/84) **Results of the radiological survey at 142 West Central Avenue, Maywood, New Jersey (MJ041).** Foley, R.D.; Crutcher, J.W. Oak Ridge National Lab., TN (USA). Jun 1989. 21p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC05-84OR21400. Order Number DE89017340/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. MCW supplied rare earth metals and thorium compounds to the Atomic Energy Commission and various other government agencies from the late 1940s to the mid-1950s. Area residents used the sandlike waste from this thorium extraction process mixed with tea and cocoa leaves as mulch in their yards. Some of these contaminated wastes were also eroded from the site into Lodi Brook. At the request of the US Department of Energy (DOE), a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally ^{232}Th, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, 142 West Central Avenue, Maywood, New Jersey (MJ041), was conducted during 1988. Results of the survey indicated scattered radiation or "shine" from a storage pile, located off the property, containing residual radioactive material. Lead-shielded measurements showed radioactivity in the range of normal background for the northern New Jersey area. Radiological assessments of soil samples from the site demonstrate no radionuclide concentrations in excess of DOE Formerly Utilized Sites Remedial Action Program criteria. 4 refs., 8 figs., 3 tabs.

5105 Site Resource and Use Studies

Refer also to citation(s) 47002, 47972, 47973, 47995, 48050

5106 Regulations

Refer also to citation(s) 47232, 47970, 48054, 48055, 48063, 48075, 48076, 48077, 48078, 48079, 48080

47999 (PB–89-189492/XAB) **Superfund Record of Decision (EPA Region 2): Asbestos Dump, Millington Site, Millington, New Jersey (first remedial action), September 1988.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. Sep 1988. 36p. (EPA/ROD/R–02-88/065). Available from NTIS, PC A03/MF A01.

The Asbestos Dump site is an 11-acre commercial property, formerly an asbestos processing plant, in Millington, New Jersey. Part of the site lies within the flood plain of the Passaic River which serves as a public water-supply source for 74,000 people. Asbestos, Limited engaged in the fiberization and sale of asbestos at the site from 1927 until 1946. From 1946 until 1953, the plant was owned by Bernard E. Smith and operated under the name of Smith Asbestos, Inc., a manufacturer of asbestos roofing and siding. Most of the waste was recaptured and recycled during this period, although broken siding and asbestos fibers were dumped on a five-acre area on the property. From 1959 until 1972, National Gypsum used phenylmercuric acetate (PMA) as a fungicide to coat the asbestos shingles. The selected remedial action for this site includes: installation of a two-foot soil cover on areas of exposed or minimally covered asbestos, construction of slope protection/stabilization measures along the asbestos mound embankment, and surface run-off diversion channels on top of asbestos mound; and long-term monitoring.

48000 (PB–89-190169/XAB) **Critique of several regulatory analyses regarding solvent wastes. Technical report.** VanderHart, P.G. Wisconsin Univ., Madison, WI (USA). Inst. for Environmental Studies. Oct 1988. 18p. Available from NTIS, PC A03/MF A01.

In 1981, President Reagan Issued Executive Order 12291, which required that major new Federal regulations undergo an analysis to quantify both the benefits that the rule would provide for society, and the costs that would be incurred. Pursuant to the order, the Environmental Protection Agency has conducted a number of regulatory analyses to evaluate its regulations. This paper is concerned with the accuracy and sophistication of the cost estimates used in several regulations that affect the disposition of solvent wastes. Its primary focus is on the analysis of the restrictions on land disposal of solvent wastes, but the Small Quantity Generator (SQG) and proposed Waste-as-fuel regulations are also examined.

48001 (PB–89-196687/XAB) **Superfund Record of Decision (EPA Region 9): Operating Industries, Inc. (OII), Monterey Park, California (third remedial action), September 1988.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 30 Sep 1988. 307p. (EPA/ROD/R–09-88/013). Available from NTIS, PC A14/MF A01.

The Operating Industries Inc. (OII) site is a 190-acre landfill located in Monterey Park, California, 10 miles east of Los Angeles. To the northwest and east of the site the land use is primarily industrial; residential units are located to the southwest, east and west of the site. In 1952, the site and additional land, totalling 218 acres, were purchased by OII. The landfill was permitted to accept household refuse, organic refuse, scrap metal, non-decomposable inert solids, and certain types of liquids. In April 1983, OII ceased accepting all liquid wastes; disposal of all solid wastes ended in October 1984. EPA currently is performing operation and maintenance of the existing leachate collection system, perimeter gas-extraction system and interior gas-extraction system. The selected remedial action at the site includes: installation of perimeter landfill gas (LFG) extraction wells, pile-driven wells on the top deck of the landfill, shallow and deep slope wells to control subsurface migration at the perimeter; and utilization of existing gas-extraction wells and gas-monitoring probes.

48002 (PB–89-196745/XAB) **Superfund Record of Decision (EPA Region 3): Dorney Road Landfill Superfund Site, Lehigh County, Pennsylvania (first remedial action), September 1988.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1988. 57p. (EPA/ROD/R–03-88/056). Available from NTIS, PC A04/MF A01.

The Dorney Road Landfill site is located in Lehigh County, Pennsylvania. The site is approximately 27 acres, bounded on the east by Dorney Road, and extends westward such that the southwest corner is in Longswamp Township, Berks County. Beginning in 1952, an abandoned iron mine pit on the site was used as an open dump. From 1966 to 1978, an unpermitted landfill was operated in the same mine pit. In 1986, EPA conducted a removal action and regraded the landfill to prevent runoff and erosion of landfill material from migrating to neighboring property. In 1980 and 1982, EPA investigations revealed elevated levels of VOCs, metals, and phenols in ground water and leachate samples. The remedial action will prevent dermal contact and incidental ingestion of landfill soil and solid waste. The primary contaminants of concern affecting the soil, ground water, and surface water are VOCs including benzene, toluene and xylenes, metals including arsenic and chromium, and other organics including phenol and PAHs. The selected remedial action for the site is included.

48003 (PB–89-196752/XAB) **Superfund Record of Decision (EPA Region 3): Wildcat Landfill, Kent County, Delaware (first remedial action), June 1988.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Jun 1988. 62p. (EPA/ROD/R–03-88/052). Available from NTIS, PC A04/MF A01.

The Wildcat Landfill site is located 2.5 miles southeast of Dover in Kent County, Delaware. A pond, created by construction of the landfill, is located directly adjacent to the site along the northwestern edge. The site was operated as a permitted sanitary landfill between 1962 and 1973, accepting both municipal and industrial wastes. Industrial wastes suspected to have been disposed of include latex waste and paint sludges. Typical wastes encountered at the site included municipal refuse latex in strips and sheets; scattered crushed, empty, or intact drums; and manufactured plastic items. Consequently, in that area of the landfill, wastes are in direct contact with the surficial sand aquifer. The primary contaminants of concern affecting the soil and ground water are VOCs including benzene, other organics including PCBs, and metals including arsenic and lead. The selected remedial actions for the site are included.

48004 (PB–89-196760/XAB) **Superfund Record of Decision (EPA Region 2): Ewan Property, Burlington County, New Jersey (first remedial action), September 1988.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency

and Remedial Response. 29 Sep 1988. 111p. (EPA/ROD/R–02-88/073). Available from NTIS, PC A06/MF A01.

The 43-acre Ewan Property site is located in a predominantly agricultural and residential area of Shamong Township, Burlington County, New Jersey. Private residences are provided domestic water from wells. The site is broken into two study areas, Area A and Area B. Area A, consisting of nine acres, is the area of concern. Site investigations revealed that during the early to mid-1970s, at least 500 to 8,000 55-gallon drums containing hazardous industrial wastes were disposed of in trenches in Area A, and the trenches were subsequently backfilled with soil. Investigations also revealed that many of the drums are ruptured, corroded, or leaking. Soil and ground-water samples indicate the presence of VOCs and metals. The selected remedial action for this site includes: construction of decontamination, staging and waste-characterization areas; excavation, staging and characterization of waste materials with offsite incineration of all appropriate wastes (approximately 4,500 cu yds of buried drums and heavily contaminated soil); temporary onsite storage and assessment of non-incinerable wastes to determine proper disposal methods; and monitoring of air and ground water during remedial activities.

48005 (PB–89-196778/XAB) **Superfund Record of Decision (EPA Region 1): Rose Disposal Pit, Lanesborough, Massachusetts (first remedial action) September 1988. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 23 Sep 1988. 108p. (EPA/ROD/R–01-88/028). Available from NTIS, PC A06/MF A01.

The Rose Disposal Pit site occupies 1.5 acres in the northern section of a 14-acre residential lot located in Lanesborough, Massachusetts, approximately 4 miles north of Pittsfield. During the 1950s and possibly later, the General Electric Company disposed of waste oils and solvents in a trench on the site, now referred to as the disposal area. Field investigations conducted between 1981 and 1986 revealed high concentrations of PCBs in surface and subsurface soils and indicated the presence of VOCs in ground water. The primary contaminants of concern affecting the soil, sediments, ground water, and surface water are VOCs including PCE, TCE, toluene, and xylenes, and other organics including PCBs. The selected remedial action for the site is included.

48006 (PB–89-196786/XAB) **Superfund Record of Decision (EPA Region 5): Kummer Sanitary Landfill, Beltrami County, Minnesota (second remedial action) September 1988.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 30 Sep 1988. 65p. (EPA/ROD/R–05-88/082). Available from NTIS, PC A04/MF A01.

See also PB–85-249548.

The Kummer Sanitary Landfill is a 40-acre site located in Northern Township, Beltrami County, Minnesota. Between 1971 and 1983 the site operated as a sanitary landfill, accepting mixed municipal waste. Beginning in 1974, demolition debris consisting of fly ash and sawdust were disposed of onsite. In 1982 and 1983 the Minnesota Pollution Control Agency sampled ground water from onsite monitoring wells and discovered 19 VOCS including TCE, PCE, and benzene. In 1984, VOCs were also discovered in offsite shallow residential wells downgradient of the site; consequently, in 1985 the site was ordered closed. Approximately 244 homes affected by contaminated ground water. Although there is no documentation of hazardous waste disposal at the site, it is believed that small quantities of wastes such as paint thinner, solvents, and pesticides were included in municipal wastes. The primary contaminants of concern affecting ground water and soil are VOCs such as TCF, PCE and benzene. The selected remedial action for the site is included.

48007 (PB–89-204747/XAB) **Superfund Record of Decision (EPA Region 1): Landfill and Resource Recovery, Rhode Island (first remedial action), September 1988. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1988. 118p. (EPA/ROD/R–01-88/032). Available from NTIS, PC A06/MF A01.

The Landfill and Resource Recovery (L and RR) site is located in North Smithfield, Rhode Island, and consists of a 28-acre landfill and a sand and gravel pit. The site is a former sand and gravel pit that began accepting domestic, commercial, and industrial wastes in 1927. In 1983, the Rhode Island Department of Health installed monitoring wells onsite to ensure compliance with State regulations, and based on sampling results, ordered the site closed. Upon final closure in 1985 the owners covered 80% of the landfill area with one foot of sand, another synthetic cover and topsoil. Eighteen gas vents were installed to vent gases underlying the synthetic cover. The selected remedial action for this site includes: access restrictions; stabilization of the steep side slopes of the landfill and installation of an RCRA cap over the entire landfill, with revegetation; collection and thermal destruction of underlying gases.

48008 (PB–89-204788/XAB) **Superfund Record of Decision (EPA Region 6): French Limited, Texas (first remedial action), March 1988. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 24 Mar 1988. 96p. (EPA/ROD/R–06-88/030). Available from NTIS, PC A05/MF A01.

Portions of this document are not fully legible.

The French Limited, Inc. (FLI) site, a 22.5-acre tract of land, is located in Harris County, Texas. The site is situated one mile east of the San Jacinto River. The entire site is within the 100-year flood plain of the River and has flooded frequently in the past. Between 1966 and 1972, approximately 300,000 cu yds of industrial wastes from area petrochemical companies were deposited in an unlined 7.3-acre pit, formerly an active sand pit. In 1982, the U.S. EPA conducted an Immediate Removal Action (IRA). The dike was repaired and the majority of discharged sludges were pumped back into the pit. Sludge and soil from the waste pit and adjacent slough include the following primary contaminants: PCBs, PCP, organics, VOCs, metals, and arsenic. The selected remedial action for this site includes: in-situ biodegradation of sludges and contaminated soils with aeration of the lagoon waste for degradation enhancement; stabilization of residues; and ground water pump and treatment.

48009 (PB–89-204796/XAB) **Superfund Record of Decision (EPA Region 6): Sol Lynn/Industrial Transformers, Texas (first remedial action), September 1988. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 23 Sep 1988. 52p. (EPA/ROD/R–06-88/040). Available from NTIS, PC A04/MF A01.

See also PB–89-128367.

The Sol Lynn site, also known as Industrial Transformers site, is located in Houston, Texas. The area around the three-quarter-acre site is a mix of residential, commercial, and light industrial facilities. Approximately 2,000 residents and 100,000 other people move within a one-mile radius of the site on a daily basis due to recreational activities associated with the area. The site operated as an electrical transformer salvage and recycling company between 1971 and 1978, and as a chemical recycling and supply company from 1979 through 1980. The first documented investigation of this site took place during the fall of 1971 when the City of Houston Water Pollution Control Division noted that workers at Industrial Transformers poured oil out of electrical transformers onto the ground during transformer dismantling. In 1981, strong odors originating from the site were brought to the attention of the Texas Department of Water Resources, the predecessor agency of the Texas Water Commission (TWC).

48010 (PB–89-204838/XAB) **Superfund Record of Decision (EPA Region 7): Shenandoah Stables, Missouri (first remedial action), July 1988.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 28 Jul 1988. 25p. (EPA/ROD/R–07-88/012). Available from NTIS, PC A03/MF A01.

The Shenandoah Stables (SS) site is located in a rural area near Moscow Mills, Lincoln County, Missouri, approximately 35 miles northwest of St. Louis, Missouri. The property includes an enclosed arena and horse stables. In May 1971, the area inside the arena was sprayed with dioxin-contaminated waste oil for dust-control purposes. Investigations were conducted by EPA in May 1982, which indicated continued exterior and interior contamination of the facility by dioxin at levels greater than 1,750 micrograms/kg. The selected remedial action for this site includes: excavation of all dioxin-contaminated surface soil exceeding 1 micrograms/kg with continued excavation until a residual concentration of 5 to 10 micrograms/kg at the 2 to 4-foot depth is reached in the arena and

slough, or excavation until bedrock is encountered, with backfilling of excavated area.

48011 (PB–89-204846/XAB) **Superfund Record of Decision (EPA Region 9): South Bay Asbestos Area, California (first remedial action), September 1988. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1988. 241p. (EPA/ROD/R–09-88/026). Available from NTIS, PC A11/MF A01.

The South Bay Asbestos (SBA) site is located at the northern end of the Santa Clara Valley and at the southernmost extent of San Francisco Bay, in Alviso, California. The site is within an area of approximately 330 acres, and is comprised of a mixture of residential, commercial, light industrial, and agricultural land uses. In August 1983, an excavation occurred on property owned by the City of San Jose involving the construction of an outfall structure at the Guadalupe River levee. The excavation revealed asbestos contamination ranging from 20 to 40% by area. The selected remedial action for the ring levee includes: stripping and rough grading of the levee; placement of a compacted soil layer and a top soil cover followed by revegetation to prevent erosion. The estimated present worth cost for this remedial action is $2,374,700.

52 ENVIRONMENTAL SCIENCES, AQUATIC

5201 Basic Studies

Refer also to citation(s) 47286

48012 (NEI-NO–83) **Acidification and water pathways. Vol. II.** Norsk Hydrologisk Komite, Oslo (Norway). 1987. 360p. (CONF-870577–Vol.2: International symposium on acidification and water pathways, Bolkesjo (Norway), 4-8 May 1987). Order Number DE89787775/JAW. Available from NTIS (US Sales Only), PC A16/MF A01.

The book is a survey over oral presentations at the symposium. The topics dealt with are: Various environmental aspects connected with acidification of water systems, deposition, catchment flow systems, watersheds, biochemistry of water pathways,and factors influencing acidification, pollution in water and air and environment generally on the macro and micro levels, ground and surface water quality and what effects it, mitigation studies and some prediction models are discussed. 158 drawings, 63 tabs., 552 refs.

48013 (ORNL/FTR–3259) **[Case studies examining energy policies and strategies for water resources development]: Foreign trip report, May 7–13, 1989.** Hildebrand, S.G. Oak Ridge National Lab., TN (USA). 24 May 1989. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017388/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler met with colleagues involved with Project 12.2 of the IHP of UNESCO to discuss and finalize case studies that are being prepared for a report entitled "Case Studies Examining Energy Policies and Strategies for Water Resources Development." Draft case studies from the United States, Brazil, Norway, and Czechoslovakia were reviewed and discussed. The traveler was appointed editor of the final report. The traveler met with staff of the National Department of Water and Electrical Energy of the Ministry of Mines and Energy, the Secretary General of the Ministry of Mines and Energy, the Executive Secretary to the National Energy Commission of Brazil, and the newly created Brazilian Institute of the Environment. The traveler was briefed on the functions of these departments, and he briefed them on water resource activities conducted at ORNL. The traveler presented a seminar at Eletrobras (national electric utility) in Brazil on environmental research at ORNL.

48014 (TR-EL–82-4/82(11.99)) **Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (South Atlantic): Black sea bass.** Mercer, L.P. North Carolina Div. of Marine Fisheries, Morehead City, NC (USA); Army Engineer Waterways Experiment Station, Vicksburg, MS (USA); National Fish and Wildlife Lab., Washington, DC (USA). Jul 1989. 16p. Sponsored by DOD;DOI. (BR–82(11.99)). Available from OSTI - US Fish and Wildlife Service, 1010 Guase Blvd., Slidell, LA 70458.

Species profiles are literature summaries on the taxonomy, morphology, range, life history, and environmental requirements of coastal aquatic species. They are designed to assist in environmental impact assessment. The black sea bass, Centropristis striata, is an abundant species associated with the inshore sponge-coral habitat in the South Atlantic Bight (Cape Hatteras to Cape Canaveral). It is a protogynous hermaphrodite (each individual is first a female and then a male) that spawns from January to June on the Continental shelf. Juveniles utilize estuaries, as well as offshore areas, for nurseries. It is a slow growing species with a life span of about 10 years. Juveniles and adults are bottom-feeding carnivores. Adults have been collected at temperatures as low as 6 °C but are most abundant at temperatures of 8 to 10 °C and above. Juveniles tolerate lower temperatures and greater salinity ranges than adults. Black sea bass are primarily harvested by the recreational hook and line fishery and the commercial trap fishery. Yield-per-recruit analyses indicate that the harvest of black sea bass is less than the maximum possible due to a combination of high fishing pressure and harvest of small fish. 58 refs., 2 figs., 6 tabs.

48015 (TR-EL–82-4/82(11.102)) **Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (North and Mid-Atlantic): Blue mussel.** Newell, R.I.E. Army Engineer Waterways Experiment Station, Vicksburg, MS (USA); National Wetlands Research Center, Slidell, LA (USA); Maryland Univ., Cambridge, MD (USA). Horn Point Environmental Labs. Jun 1989. 25p. Sponsored by U.S. Department of the Interior. (BR–82(11.102)). Available from OSTI; Fish and Wildlife Service, NASA-Slidell Computer Complex, 1010 Gause Blvd., Slidell, LA 70458.

The blue mussel, Mytilus edulis L. is a widely distributed and locally abundant bivalve mollusc in the North and Mid-Atlantic Regions. It is a valuable commercial species; regional landings in 1986 were worth nearly $4 million. It is a semi-sessile species, anchored by byssus threads to firm surfaces in littoral and sub-littoral environments at salinities ranging from 5 to 35 ppt. It is a suspension feeder, ingesting phytoplankton and detrital particles in the size range of 3–30 μm. The geographical range of the species is limited by lethal water temperatures above 27°C in the south and by temperatures too low for growth and reproduction in the north. Animals from the northern end of the range are stressed by temperatures above 20°C, whereas those near the southern distributional limit are not severely stressed by temperatures as high as 25°C. The blue mussel is diecious and oviparous. The planktotrophic larvae take about 3 weeks to develop and metamorphose. The environmental tolerances of larvae are more restricted than those of adults. The juveniles grow to approximately 1.5 mm while attached to filamentous algae before being carried by water currents to reattach to a firm substrate, often close to adult mussels. Larval and adult blue mussels are important prey items for many animals, including crabs, fishes, and birds. 95 refs., 5 figs., 2 tabs.

48016 (TR-EL–82-4/82(11.103)) **Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest): Pile perch, striped seaperch, and rubberlip seaperch.** Fritzsche, R.A.; Hassler, T.J. Humboldt State Univ., Arcata, CA (USA). Dept. of Fisheries; Humboldt State Univ., Arcata, CA (USA). California Cooperative Fishery Research Unit. Jul 1989. 22p. Sponsored by DOD;DOI. Available from OSTI - US Fish and Wildlife Services, 1010 Gause Blvd., Slidell, LA 70458.

Species profiles are literature summaries of the taxonomy, morphology, range, life history, and environmental requirements of coastal aquatic species. They are designed to assist in environmental impact assessment. Pile perch, striped seaperch, and rubberlip seaperch are popular sport fishes along the entire California coast. They are relatively common near wharves, pilings, jetties, and other nearshore structures. All members of this family are viviparous. Fecundity is positively correlated with size and age of the female. The young are released as miniature adults. All three species are relatively large for the family and may live 7 to 10 years. The primary prey items of all three species are various invertebrates; however, pile perch tend to prefer hard-shelled prey. The habitats of the three

species overlap considerably. Little is known of their environmental tolerances. 50 refs., 2 figs., 4 tabs.

5202 Chemicals Monitoring and Transport

Refer also to citation(s) 46899, 46900, 47300, 47479, 47929, 47940, 47977, 47981, 47982, 47984, 47985, 47986, 48012, 48082, 48150, 48155

48017 (AD-A–206276/8/XAB) **Preliminary assessment/site investigation: Tooele Army Depot, Utah. Volume 2. South Area. Final report.** Lapins, A.; McConnell, L.; Porter, T. EA Engineering, Science, and Technology, Inc., Sparks, MD (USA). 29 Dec 1988. 122p. (EA-THA–51E5-VOL-2). Available from NTIS, PC A06/MF A01.

See also Volume 2, Appendixes, AD-A206 277.

This report documents the Preliminary Assessment /Site Investigation (PA/SI) phase of the U.S. Army Installation Restoration Program for the South Area of Tooele Army Depot (S-TEAD), Utah. The PA/SI for S-Tead involved the performance of a records search, and the development and implementation of a preliminary field sampling and analysis program. The objectives of the PA/SI were: (1) Identify S-TEAD sites used to store, process, and/or dispose of hazardous waste; (2) Determine which of these sites have a low potential for environmental contamination and/or pose a threat to public health and welfare; and (3) Perform limited sampling of soil, ground water, and/or surface water to determine the existence of contamination, if any to evaluate offsite migration potential.

48018 (AD-A–206659/5/XAB) **Engineering and economic analysis of containment area/wetlands disposal options in New York harbor. Final report.** Poindexter, M.E. Army Engineer Waterways Experiment Station, Vicksburg, MS (USA). Environmental Lab. Feb 1989. 145p. (WES/TR/EL–89-2). Available from NTIS, PC A07/MF A01.

Investigations were conducted to evaluate the engineering feasibility of constructing dredged material disposal sites at four locations within the New York Harbor area. The four sites identified by the New York District for evaluation were Bowery Bay, New York; Flushing Bay, New York; Newark Bay, New Jersey; and Raritan Bay, New Jersey. Each of these locations was evaluated for use with three disposal options: (a) disposal of uncontaminated sediments in a containment area; (b) disposal of contaminated sediments in a containment area; and (c) disposal of uncontaminated sediments to stabilize/create wetland habitats. Geotechnical analyses were conducted to evaluate the feasibility and cost of dredged material retaining dike construction. Retaining dike construction was found to be technically feasible, and a recommended dike design was presented for each site. Storage capacity evaluations were conducted for each disposal option to determine the ultimate quantity of material to be placed at each site. Total costs associated with each disposal option were determined including costs for marsh plantings.

48019 (CONF-881054–Vol.4, pp. 1153-1164) **Characterization of hazardous spill transport in the Clinch River, Tennessee.** Vadnal, J.L. (Tennessee Valley Authority Engineering Lab., Norris (USA)). Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

At the request of Oak Ridge National Laboratory, the Tennessee Valley Authority Engineering Laboratory conducted a field study on the Clinch River during May 1987 to better describe contaminant transport and dispersion in the Clinch River. The field study was designed to provide insight into the transport and mixing processes necessary for analyzing potential spills through mathematical simulations. During the field study, Rhodamine WT dye tracer was introduced into the Clinch River by two means. One was through a vertical line source during a 25-minute period. The other was as a vertical plane source slug. Lateral and longitudinal dye concentration profiles from the transport and dispersion of the resulting dye tracer plume were observed and measured. Detailed vertical and lateral temperature, flow velocity and depth profiles were measured at numerous river cross sections. A summary and analysis of the field study is presented. The data were used to estimate dispersion and diffusion coefficients and will verify a mathematical flow and transport model for the Clinch River. The field study results will be applied to real-time simulation of plume dispersal along the Clinch River. Installation of an emergency response procedure for any future potentially-hazardous spill is planned.

48020 (CONF-881054–Vol.4, pp. 1165-1176) **Use of analytical models to characterize contaminant exposures in aquifers with limited field data.** Ho, J. (NUS Corp., Pittsburgh, PA (USA)); Bonk, D.L. Analysas Corp., Oak Ridge, TN (USA). 1988. From 4. annual DOE model conference; Oak Ridge, TN (USA); 3-7 Oct 1988. In *1988 DOE model conference proceedings. Volume 4.* Order Number DE89014703/JAW. Available from NTIS, PC A15/MF A01.

When limited data is available to describe a contaminated aquifer, a public health risk assessment of a hazardous waste site often can be conducted with analytical models and appropriate engineering assumptions. These simplifying assumptions serve to approximate information missing from the field data and to form an idealized model of the site. When simplifying assumptions can be adequately applied to the analysis of an aquifer, an analytical model is an efficient and economical tool for site screening, site delisting, rapid assessment of emergency conditions, and sensitivity analysis. For a study conducted at two adjacent sites located in the southwestern US, four analytical models were used to simulate the concentrations of ground water contaminants down gradient from identified sources. The results of this study indicate that both the simplified and more realistic analytical models can be applied, depending on the availability of the data and the project objective. This paper also demonstrates how field data obtained from an initial remedial investigation can be utilized with a realistic computer model.

48021 (KFK-PWAB–1) **Water-Waste-Soil Project: 1st Report on the status colloquium.** Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projekt Wasser-Abfall-Boden (PWAB). Jul 1988. 266p. (In German). (CONF-8802150–: 1. status colloquium on the Water-Waste-Soil Project, Karlsruhe (Germany, F.R.), 23 Feb 1988). Order Number DE90702886/JAW. Available from NTIS (US Sales Only), PC A12/MF A01.

The priorities set by the Project Committee concerning waste, water, soil, and waste water are presented, and preliminary research findings are discussed. The emphasis is on experimental studies on the sanitation of abandoned sites and studies on the causes, consequences and prognosis of long-term changes of the soil and groundwater quality. Another field of central interest was the reduction of groundwater and soil contamination in agriculture. (EF).

48022 (ORNL/FTR–2822) **[Collection of North Pacific Ocean surface seawater samples for chemical analysis]: Foreign trip report, January 26–February 27, 1988.** Goddard, J.G. Oak Ridge National Lab., TN (USA). 4 Mar 1988. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017405/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This trip was a continuation of the sampling program undertaken during 1984–1985 to study the seasonal and regional variability of CO_2 chemistry in high latitude deep water formation areas of the North Pacific. The work is conducted by Columbia University (Dr. Taro Takahashi, Principal Investigator) for the Department of Energy's Energy Systems Program managed by Oak Ridge National Laboratory. Aboard the PRESIDENT ARTHUR, surface seawater samples were collected at forty-one stations along the route from Oakland, California, to Keeling, Taiwan, via Guam. On the return trip, samples were collected from thirty-seven stations during transit from Keelung to Los Angeles, California.

48023 (ORNL/FTR–3305) **[Groundwater movement models: A review]: Foreign trip report, June 14–17, 1989.** Yeh, G.T. Oak Ridge National Lab., TN (USA). 27 Jun 1989. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017383/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler attended a technical meeting held at Taipower Company Headquarters in Taipei on June 14 through 17, 1989. On the first day of the meeting, the final reports on groundwater movement models and monitoring systems design at nuclear power plant sites

were presented by National Taiwan University (NTU) investigators. Comments and recommendations were offered by the traveler. On the second day of the meeting, the final report on a contaminant transport study was presented by the NTU staff, and comments and specific recommendations were made by the traveler. The traveler and NTU investigators spent a total of about two and a half days on the implementation of the computer code LEMA. One of the problems encountered in applying LEMA to the tracer test was the occurrence of negative concentrations at the source. Theoretically, this should not happen in the LEMA code. Causes for the negative concentrations were uncovered, and corrective measures were taken.

48024 (ORNL/FTR–3355) **[Water-rock interaction]: Foreign trip report, August 1–15, 1989.** Von Damm, K.L. Oak Ridge National Lab., TN (USA). 17 Aug 1989. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017234/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler attended the Sixth International Symposium on Water-Rock Interaction, Malvern, United Kingdom, at which she presented a paper entitled "Geochemical Controls on Groundwater Chemistry in Shales." The traveler also participated in the postsession field trip to Cornwall, United Kingdom, which included visits to areas of tin mineralization, kaolinite quarries, the Lizard ophiolite, and the experimental Hot Dry Rock Project site. The emphasis of the symposium was the importance of water-rock interactions to environmental and geological problems and processes. Topics at the symposium ranged from air-water interaction to geothermal and metamorphic fluids, and from detailed field studies to the theoretical thermodynamics of the reactions. In contrast to many meetings in the earth sciences, the role of fluids (on which the traveler works primarily) was strongly emphasized.

48025 (ORNL/Sub–89-SD212V/1) **Feasibility of adding TCE [trichloroethylene] still area and Northeast area plumes to ultraviolet radiation, ozone, hydrogen peroxide groundwater treatment plant, Department of Energy Kansas City Plant.** Peyton, G.R. Peyton (Gary R.), Champaign, IL (USA). Aug 1989. 79p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89015662/JAW. Available from NTIS, PC A05/MF A01 - OSTI.

The Department of Energy (DOE) Kansas City plant currently operates an Ultrox F-725 ozone/ultraviolet radiation/hydrogen peroxide plant for the treatment of groundwater that has been contaminated by halogenated volatile organic compounds (VOCs). The treated water is discharged to the municipal wastewater treatment plant and must, therefore, meet the effluent water quality discharge requirements specified in the discharge permit. The DOE Kansas City plant would like to treat additional groundwater streams from other areas of contamination using the same technology and, if possible, the same treatment unit. The current unit is rated by the manufacturer at 25 gallons per minute (gpm). However, operation at 5.5 to 6.0 gpm produces an effluent which, on some occasions, barely meets the effluent water quality standards specified in the discharge permit. The overall purpose of this study was to determine if the present groundwater treatment plant can handle additional flow from other groundwater streams. 15 refs., 11 figs., 5 tabs.

48026 (ORNL/TM–11056) **An evaluation of the use of a combination of ozone, ultraviolet radiation, and hydrogen peroxide to remove chlorinated hydrocarbons from groundwater at the Department of Energy Kansas City Plant: Fiscal year 1988, annual report.** Garland, S.B. II. Oak Ridge National Lab., TN (USA). May 1989. 56p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89015678/JAW. Available from NTIS, PC A08/MF A01 - OSTI; GPO Dep.

The Department of Energy Kansas City Plant selected a treatment process that uses ozone, ultraviolet radiation, and hydrogen peroxide for the removal of trichloroethene from the underlying groundwater. Since the use of this process is not well-documented in the literature, this evaluation was initiated to determine its performance, costs, and operating history. During the first year of the study, the flow rate remained at approximately 27% of the design flow rate, while the operating parameters varied from 50% to full treatment capacity. Consequently, it was difficult to evaluate the true performance of the plant. Throughout the 6 months of operation, all effluent standards were met, and all volatile organic compounds (VOCs) were reduced below detectable limits; but two problems were seen. First, despite the apparent overtreatment, neither the removal of total organic carbon and total organic halogens (TOX) nor the oxidation of iron and manganese were as great expected, which indicates a potential problem in the utilization of ozone. Second, the TOX concentrations in the plant effluent were always greater than the concentrations in the final stage of the ozone reaction chamber and sometimes approached the effluent standard. There may be an inherent limitation in the use of TOX as a control parameter, and its replacement with one or more individual VOCs should be considered. 28 refs., 3 figs., 29 tabs.

48027 (ORNL/TM–11216) **Hydrogeology of Melton Valley determined from hydraulic head measuring station data.** Dreier, R.B.; Toran, L.E. Oak Ridge National Lab., TN (USA). Jun 1989. 205p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89016934/JAW. Available from NTIS, PC A11/MF A01; OSTI; INIS.

The hydraulic head measuring stations (HHMSs) are well clusters that provide data required for evaluating both the transition between shallow and deep groundwater system(s) and the nature of the deep system(s). This information can be used to aid the characterization of the local hydrologic framework as dictated by state and federal regulatory agencies. Specifically this project provides a means for defining the lower boundary of the uppermost aquifer and for identifying potential pathways for off-site contaminant migration for shallow, intermediate, and deep groundwater flow. In addition, this project provides some of the geologic and hydrologic background information required to perform a risk assessment for individual waste sites. The objectives of the HHMS general plant projects are threefold: (1) to characterize potentiometric head levels in and near waste management areas in Melton Valley, (2) to characterize the geology in Melton Valley, and (3) to determine groundwater quality at their respective locations. This report presents results of data collected from wells constructed in FY 1986 and FY 1988. To meet these objectives, each HHMS was designed to consist of three telescoping wells, approximately 25 ft apart. The deepest well was drilled to approximately 400 ft, and the intermediate and shallow wells are approximately 200 and 80 ft deep, respectively. The open interval extends at least 20 ft below the bottom of the cased section of each well. 25 refs., 25 figs., 8 tabs.

48028 (ORNL/TM–11265) **Environmental studies in support of the live fire training facilities project.** Hylton, T.D.; Walker, J.F. Oak Ridge National Lab., TN (USA). Aug 1989. 55p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. Order Number DE89016940/JAW. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The Engineering Division of the Oak Ridge National Laboratory of Martin Marietta Energy System, Inc., provided services, under an Interagency Agreement, to the US Air Force to design, construct, and test environmentally acceptable fire training facilities at several Air Force bases for the purpose of providing live fire training capabilities without harming the environment. The purpose of this effort was to evaluate the wastewater treatment systems of the training facilities. The study focused on taking a set of background samples at a facility and then allowing the Air Force to conduct a series of training exercises. A set of samples was taken immediately following the training exercises to determine the effect the exercises had on the wastewater in the fuel/water separator and the holding pond. The separator and pond were also allowed to set undisturbed, except for sampling and environmental influences, for ~60 d to determine if any stripping or biodegradation was occurring. Samples of the separator and pond were taken at 2, 4, 6, 8, 10, 11, 32, and 59 d following the training exercises. In addition, the burn pit was sampled immediately following the extinguishment of a fire and then again after the burn pit was flushed with water to determine if the materials remaining could be classified as hazardous under the Resource Conservation and Recovery Act (RCRA). 16 figs., 11 tabs.

48029 (ORNL/TM–11300) **Stability of volatile organics in environmental water samples: Storage and preservation: Final report.** Maskarinec, M.P.; Bayne, C.K.; Johnson, L.H.; Holladay, S.K.; Jenkins, R.A. Oak Ridge National Lab., TN (USA). Aug 1989.

139p. Sponsored by DOD;EPA. DOE Contract AC05-84OR21400. Order Number DE89016916/JAW. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

The purpose of this work was to establish the stability of volatile organic compounds in environmental water samples. The stability of common volatile organic compounds was determined in three types of waters, distilled water, a groundwater, and a surface water. Two concentration levels were studied: nominally 50 μg/L and 500 μg/L. Samples were stored at two conditions, room temperature and under refrigeration (4°C). Samples were analyzed at intervals of 0, 3, 7, 14, 28, 56, 112, and 365 days. The data from this study indicates that most volatile organic compounds are stable in water for longer than 365 days. Exceptions to this statement include compounds prone to dehydrohalogenation (e.g., 1,1,2,2-tetrachloroethane) and compounds prone to biological degradation, particularly the volatile aromatics. The stability of the compounds was matrix dependent and storage condition dependent. Within the limits of this study, the minimum holding time for an environmental water sample prior to analysis for volatile organic compounds is about ten days, although for most of the compounds, stability is not a problem up to 365 days. Because of the fact that the degradation observed in this study could apparently be controlled by preservation with acid, a second study was conducted comparing three acids for preservation of the samples. The same three water matrices were studied. Samples were preserved with hydrochloric acid (HCl), sodium bisulfate, and ascorbic acid. For the most part, all three acids effectively reduced the degradation and preserved the samples. 13 refs., 46 figs., 53 tabs.

48030 (PB–89-178594/XAB) **Biodegradation of trichloroethylene and biomanipulation of aquifers. Technical report (Final).** Jaffe, P.R.; Taylor, S.W.; Baek, N.H.; Christopher, P.; Milly, D. Princeton Univ., NJ (USA). Dept. of Civil Engineering and Operations Research. Aug 1988. 198p. Available from NTIS, PC A09/MF A01.

Three distinct aspects of the biodegradation process in a porous media were addressed. The effect of the trichloroethylene(TCE) concentration on bacterial activity was investigated. The results showed that the dissolved-phase concentration directly affects the bacterial activity. For aerobic soils, LD50 for water concentrations ranged between 200-300 mg/l for CO_2 evolution, and 80 to 150 mg/l for dehydrogenase activity. The degradation of TCE and its intermediates by mixed cultures containing fermenters and methanogens was investigated. Results showed that fermenters play an important role in this process and that the degradation rate correlates with the methanogenic activity. It was shown that TCE can be degraded by these mixed cultures via 1,1-dichloroethylene to vinyl chloride, to chloroethane which is readily degradable. Kinetic rates were obtained for this degradation process and normalized with respect to the methane production. The effect of biomass production in porous media on the permeability and dispersivity was investigated. Experimental results showed that the permeability of a sandy media depends on the biomass if the biomass is less than 0.4 mg of organic carbon/cu cm, and becomes independent of the biomass for higher values. Changes in permeability and dispersivity as a function of the biofilm thickness were modeled successfully using a modified cut-and-random-rejoin-type model.

48031 (PB–89-181325/XAB) **Modified purge-and-trap/gas-chromatography method for analysis of volatile halocarbons in microbiological degradation studies (journal version).** Cochran, J.W.; Yates, M.V.; Henson, J.M. Northrop Services, Inc., Ada, OK (USA). 1988. 10p. Available from NTIS, PC A02/MF A01.

Pub. in Jnl. of Microbiological Methods, Vol. 8, No. 6, 347-354(Nov 1988).

A modification of a purge-and-trap unit is described for use in microbiological studies concerning degradation of aliphatic halogenated hydrocarbons (halocarbons). Sealed serum tubes containing bacteria, aqueous medium, headspace, and volatile halocarbons are used as purge vessels to monitor the disappearance of the halocarbons. Data are presented to show the loss of volatile halocarbons that occurred when these systems were analyzed by standard purge-and-trap. An application of this method is shown with methane-utilizing bacteria. The modified purge-and-trap method resulted in a total measurement of halocarbons in the sample without making a transfer to a separate purge vessel.

48032 (PB–89-181408/XAB) **Generalized ground-water sampling device matrix (journal version).** Pohlmann, K.F.; Hess, J.W. Nevada Univ., Las Vegas, NV (USA). Water Resources Center. 1988. 5p. Available from NTIS, PC A02/MF A01.

Pub. in Ground Water Monitoring Review, Vol. 8, No. 4, 82-84(1988).

The sampling matrix is based on a review of the literature. It illustrates general relations of ground-water parameters to sampling devices. Twelve types of sampling devices and 14 ground-water parameters (including inorganic, organic, radioactive, and biological) were considered. Notes regarding sampling depths, well diameters, sample delivery rates, and construction materials are included.

48033 (PB–89-181598/XAB) **Charles River lower basin artificial destratification project. Final report.** Ferullo, A.F.; DiPietro, P.J.; Shaughnessy, R.J. Massachusetts Metropolitan District Commission, Boston, MA (USA). Jun 1981. 50p. Available from NTIS, PC A03/MF A01.

The Charles River Basin which was created by construction of a dam in 1910 has been stratified since that time with salt water intruding from Boston Harbor through a boat lock and leaky sluices. In order to eliminate nuisance conditions and fish kills caused by hydrogen sulfide from the anoxic bottom water, destratification by air-mixing was initiated in the spring of 1978. Six diffusers were installed on the bottom in the deep sections of the Basin and operated as necessary to induce sufficient circulation to maintain a minimum of 4.0 mg/l dissolved oxygen throughout the water column. After two and a half years of operation, hydrogen sulfide has been eliminated and water quality has generally improved in the area of the Basin influenced by the diffusers.

48034 (PB–89-189427/XAB) **Extent and trend of nitrate contamination in Region III: The Coastal Plain and Piedmont Province. Technical report.** Passmore, M.E. Drexel Univ., Philadelphia, PA (USA). Dept. of Environmental Studies. 1988. 60p. Available from NTIS, PC A04/MF A01.

This study is part of the National Network for Environmental Management Studies under the auspices of the Office of Cooperative Environmental Management of the Environmental Protection Agency. This is a study of the extent and trend of ground-water contamination in the Coastal Plain and Piedmont Provinces of Region III. The region was analyzed by geologic province to take advantage of the similar ground-water conditions and common aquifers in each province. Several different environmental indicators and sources of data could be used to determine trends in ground-water quality. Nitrate levels were used as the water quality indicator in the report because they are commonly reported in ground water analyses and are often used as an indicator of surface contamination of ground water. Existing literature, the STORET database and the FRDS data base, were the primary data resources used for the project.

48035 (PB–89-189708/XAB) **Fiscal year 1988 measurable environmental results initiatives: Underground storage-tank impacts on ground water. Technical report.** Mason, M. Colorado Univ., Boulder, CO (USA). 1988. 58p. Available from NTIS, PC A04/MF A01.

For FY 1988, an Underground Storage Tank (UST) Measurable Environmental Results Initiative (MERIT) Project was undertaken to map and evaluate high risk USTs (tanks greater than 15 years of age) within ten counties. Hydrogeologic setting and proximity of the facility to public wells were used to measure the potential impact of USTs on sensitive ground-water areas. The information may be used to generate a prioritized list of USTs for states to use in monitoring and compliance. In addition, the mapping process was evaluated to identify problems that may limit and procedures that may expedite mapping UST facilities, should any state consider a similar project. It was found that mapping was time-consuming, with most site information being obtained by telephoning the tank contact person. Also, detailed road maps were found to be essential in locating and mapping UST facilities. The objectives were to evaluate the information in the UST Notification Data Base in terms of ability to locate UST sites, to determine the feasibility of locating UST sites as well as to provide a methodology for establishing compliance monitoring and

enforcement priorities for UST facilities based on hydrogeologic setting, proximity to public water supply, and age of tank.

48036 (PB–89-189757/XAB) **Utility of surface-floating Chironomidae pupal exuviae in assessing the impact of PCBs on two stream communities. Technical report.** Wright, C.A. California Univ., Berkeley, CA (USA). Graduate School of Public Policy. 1988. 49p. Available from NTIS, PC A03/MF A01.

Surface-floating pupal exuviae of the midge family Chironomidae were collected from two stream systems with a known history of PCB pollution. Sites from Holden, Missouri were separated into PCB absent and PCB present groups and their taxa were analyzed for differences in composition and abundance. The PCB-absent sites had a higher total frequency of specimens and a higher total species richness than PCB present sites. Orthocladiini were present at every site except one in the PCB absent category whereas the PCB present category contained only two with Orthocladiini present. Scatterplots and correlation of taxa frequencies vs. PCB levels revealed specific taxa that may be more tolerant of PCBs than others. These taxa included Larsia sp., Einfeldia sp.gp.A, Dicrotendipes sp. 1, Geoldichironomus holoprasinus, Glyptotendipes sp.gp.A, Paratanytarsus inopertus gp. and Procladius subiettei.

48037 (PB–89-189765/XAB) **Water-pollution abatement expenditures in the Wisconsin paper industry. Technical report.** Peterson, T.B. Wisconsin Univ., Madison, WI (USA). Inst. for Environmental Studies. 1988. 52p. Available from NTIS, PC A04/MF A01.

This study estimates the costs incurred by paper mills in the State of Wisconsin to comply with water-pollution-control requirements and compares these costs to those incurred by similar mills in other states. Compared to 1965, discharges of conventional pollutants from Wisconsin's 47 paper mills have been reduced by about 90%. Current operating costs for treatment systems at Wisconsin paper mills are approximately $60 million annually. Paper mills in Georgia and Alabama spend less for waste-water treatment than Wisconsin mills as a result of several differences including: age and size of mills, product mix, production technology, and waste treatment technology. Paper mills in Wisconsin appear to be controlling waste-water discharges more effectively than mills in the other states based on the comparative incidence of discharge permit violations. The focus of waste-water treatment at Wisconsin paper mills is on toxic pollutants, especially dioxins and polychlorinated biphenyls (PCBs). Control of these toxic pollutants, which occur at low concentrations in mill effluent but which bioaccumulate to high concentrations in fish tissue, is costly and controversial.

48038 (PB–89-190367/XAB) **Cost and performance of membranes for organic control in small systems: Flagler Beach and Punta Gorda, Florida. Final report, 1 June 1986-28 February 1989.** Taylor, J.S.; Mulford, L.A.; Barrett, W.M.; Duranceau, S.J.; Smith, D.K . University of Central Florida, Orlando, FL (USA). Dept. of Civil Engineering and Environmental Sciences. May 1989. 272p. Available from NTIS, PC A12/MF A01.

This project documented the performance and cost of low-pressure membrane technology to remove THM precursors from drinking water. A 12,500-gpd membrane pilot plant was operated for one year at both ground-water and surface-water source test sites in Florida. Use of this type of membrane technology on such surface water will require lower membrane flux, lower recovery, more-frequent membrane cleanings, and extensive pretreatment. Capital costs for such an application will be significantly higher than conventional treatment.

48039 (PB–89-192355/XAB) **Estimated low-range costs for the removal of inorganics, radionuclides, and corrosion-related contaminants from potable water supplies (draft), January 1987.** Environmental Protection Agency, Washington, DC (USA). Office of Drinking Water. 9 Jan 1987. 46p. Available from NTIS, PC A03/MF A01.

This document estimates low-range costs for the removal of inorganics, radionuclides, and corrosion-related contaminants from potable-water supplies.

48040 (PB–89-192363/XAB) **Technologies and costs for the treatment and disposal of waste byproducts from water treatments for the removal of inorganic and radioactive contaminants (revised draft), September 1986.** Environmental Protection Agency, Washington, DC (USA). Office of Drinking Water. 23 Sep 1986. 229p. Available from NTIS, PC A11/MF A01.

The U. S. Environmental Protection Agency (EPA) is establishing National Primary Drinking Water Regulations for a number of inorganic, radionuclide and corrosion related contaminants. The document evaluates waste disposal options, and associated costs, for drinking water treatment processes which remove the following contaminants: nitrates, barium, mercury, silver, arsenic, selenium, chromium, cadmium, lead, copper, cyanide, fluoride, radon, uranium, man-made radionuclides and radium. The report identifies the options for disposing of the waste byproducts from the drinking water treatment processes and develops cost estimates for the specific waste disposal options.

48041 (PB–89-192447/XAB) **Cost supplement to technologies and costs for the removal of asbestos from potable-water supplies (first draft), February 1987.** Environmental Protection Agency, Washington, DC (USA). Office of Drinking Water. 13 Feb 1987. 117p. Available from NTIS, PC A06/MF A01.

The cost estimates in the document is a supplement to the cost estimates of the February 5, 1986, report entitled, 'Technologies and Costs for the Removal of Asbestos from Potable Water Supplies.'

48042 (PB–89-192462/XAB) **Cost supplement to the removal of cadmium from potable-water supplies (first draft), February 1987.** Environmental Protection Agency, Washington, DC (USA). Office of Drinking Water. 3 Feb 1987. 141p. Available from NTIS, PC A07/MF A01.

The cost estimates in the document is a supplement to the cost estimates of the April 1, 1985, report entitled, 'Technologies and Costs for the Removal of Cadmium from Potable Water Supplies.'

48043 (PB–89-192496/XAB) **Cost supplement to technologies and costs for the removal of selenium from potable-water supplies (first draft), February 1987. Draft report.** Environmental Protection Agency, Washington, DC (USA). Office of Drinking Water. 13 Feb 1987. 139p. Available from NTIS, PC A07/MF A01.

The cost estimates in the document supplement the cost estimates of the November 18, 1985 report entitled, 'Technologies and Costs for the Removal of Selenium from Potable Water Supplies'.

48044 (PB–89-192504/XAB) **Technologies and costs for the removal of synthetic organic chemicals from potable-water supplies. Appendix A: Estimation of carbon usage rates, March 1989.** Environmental Protection Agency, Washington, DC (USA). Office of Drinking Water. Mar 1989. 356p. Available from NTIS, PC A16/MF A01.

Portions of this document are not fully legible.

EPA is currently establishing MCLs for a number of synthetic organic chemicals (SOCs) which might occur in contaminated water supplies. This document assists EPA to define 'best available technology' (BAT) to remove SOCs from water supplies. The document considers the effectiveness of treatment technologies to remove contaminants and the level of treatment that is affordable for water systems.

48045 (PB–89-195218/XAB) **Toxicity Reduction Evaluation protocol for municipal waste-water treatment plants. Report for 1 February-30 September 1988.** Botts, J.A.; Braswell, J.W.; Zyman, J.; Goodfellow, W.L.; Moore, S.B. Engineering-Science, Inc., Fairfax, VA (USA). Apr 1989. 77p. Available from NTIS, PC A05/MF A01.

This document presents a generalized protocol for conducting a Toxicity Reduction Evaluation (TRE) at a municipal waste-water treatment plant (WWTP). The protocol is designed to provide guidance to municipalities in preparing TRE plans, evaluating the information generated during TREs, and developing a technical basis for the selection and implementation of toxicity-control methods. A TRE involves an evaluation of the municipal WWTP performance; an identification of the specific toxicants causing effluent toxicity; a review of the pretreatment and local limits programs; a characterization of the nature, variability and sources of toxicity; and the evaluation, selection and implementation of the toxicity-control

options. Because of the broad scope of this protocol, it is to be expected that site-specific considerations may to some extent warrant modifications and tailoring of the protocol approach for a given facility. The protocol was developed based on current research and experience. TRE methods and procedures will be updated and refined based on the results of ongoing research and case studies.

48046 (PNL–6907) **Hanford wells.** McGhan, V.L. Pacific Northwest Lab., Richland, WA (USA). Jun 1989. 410p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC06-76RL01830. Order Number DE89016584/JAW. Available from NTIS, PC A18/MF A01 - OSTI; GPO Dep.

The Site Characterization and Assessment Section of the Geosciences Department at Pacific Northwest Laboratory (PNL) has compiled a list of wells located on or near the Hanford Site. Information has been updated on wells existing from the days before construction of the Hanford Works to the present. This work was funded by the US Department of Energy (DOE). The list of wells will be used by DOE contractors who need condensed, tabular information on well location, construction, and completion dates. This report does not include data on lithologic logs and ground-water contamination. Moreover, the completeness of this list is limited because of new well construction and existing well modifications, which are continually under way. Despite these limitations, this list represents the most complete description possible of data pertaining to wells on or adjacent to the Hanford Site. 7 refs., 1 fig., 2 tabs.

5203 Radioactive Materials Monitoring and Transport

Refer also to citation(s) 46977, 46984, 47125, 47127, 47130, 47966, 47985, 47989, 47990, 48019, 48020, 48544

48047 (CEA-TR–2433) **Seasonal dynamics of ^{60}Co uptake by freshwater algae under natural conditions.** Koulikov, N.V.; Trapeznikov, A.V. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Aug 1988. 5p. (In French). Order Number DE90701460/JAW. Available from NTIS (US Sales Only), PC A02/MF A01.

The data presented in the present report show that the values of ^{60}Co uptake coefficient in freshwater algae under naturel conditions can change 5-6 times depending on seasons, reaching maximum values in summer. Specific activity of the radionuclide in water can be essentially changed depending on the nuclear power plant operation mode. In such a nonequilibrium system it is rather questionable to use the uptake coefficient as a constant parameter for the determination of the radionuclide specific activity in water.

48048 (KURRI-TR–310, pp. 19-22) **Experiment on removal of radon in water by using of de-airing membrane.** Takahara, Shinichi (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)). Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. Dec 1988. (In Japanese). (CONF-8809395–: Workshop on development of advanced technology for scientific research, Kumatori (Japan), 12-13 Sep 1988). In *Development of advanced technology for scientific research.* Order Number DE89018006/JAW. Available from NTIS (US Sales Only), PC A04/MF A01.

Published in summary form only.

48049 (ORNL/FTR–3301) **[Agricultural countermeasures following an accidental release of radionuclides]: Foreign trip report, June 11–22, 1989.** Auerbach, S.I. Oak Ridge National Lab., TN (USA). 5 Jul 1989. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017467/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report describes foreign travel of S. I. Auerbach of the Environmental Sciences Division (ESD), Oak Ridge National Laboratory (ORNL), who attended workshops dealing with radioecological protection studies of the northeast Atlantic and with agricultural countermeasures following a nuclear accident. These workshops were sponsored by the Commission of the European Community (CEC) and the International Union of Radioecologists (IUR). As past president of the IUR and member of its Executive Committee, the traveler also participated in the annual meeting of that organization. The workshop on marine radioecology heard the reports of four marine research groups: (1) studies of nuclear effluent discharges into North European waters; (2) studies of transport and fate of radionuclides; (3) radioactivity of marine produce; and (4) collective dose assessment. These investigations are being carried out by large research groups in the United Kingdom, Denmark, West Germany, Ireland, Sweden, Holland, Belgium, and France. The reports were informative from both the radioprotection and radioecological research viewpoints.

5205 Site Resource and Use Studies

Refer also to citation(s) 47234, 48046, 48083

48050 (PB–89-207484/XAB) **Understanding the estuary: Advances in Chesapeake Bay research.** Lynch, M.P.; Krome, E.C. Environmental Protection Agency, Annapolis, MD (USA). Chesapeake Bay Program. Aug 1988. 640p. (CBP/TRS–24/88). Available from NTIS, PC A99/MF A01.

The conference proceedings provides a context for assessing the relevance of scientific findings to the long-term efforts to protect and restore the Chesapeake watershed. The conference was primarily oriented towards scientists engaged in research on fundamental estuarine processes in Chesapeake Bay and secondarily oriented to managers with scientific and technical backgrounds.

5206 Regulations

Refer also to citation(s) 47232, 47298, 47970, 47999, 48001, 48002, 48003, 48004, 48005, 48006, 48007, 48008, 48009, 48010, 48011

48051 (PB–89-149314/XAB) **Sludge Incineration Modeling (SIM) system user's guide. Draft report.** General Sciences Corp., Laurel, MD (USA). Mar 1989. 68p. (GSC-TR–89-007). Available from NTIS, PC A04/MF A01.

For system on magnetic tape, see PB–89-138762.

A user-friendly, menu-driven PC version of the Industrial Source Complex Long-Term (ISCLT) model was implemented to support EPA regulations regarding incineration of sewage sludge under Section 405(d) of the Clean Water Act. The model will be made available to the public as part of the support for the proposed sewage-sludge incineration regulation. The Sludge Incineration Modeling (SIM) system comprises five components: (1) Build ISCLT Input File, (2) Run ISCLT, (3) SIM Post Processor, (4) Terrain Utility, and (5) Run Catalog Manager. The purpose of the user's guide is to describe how to use the components of the SIM system. Instructions on how to load the system and descriptions of screen design, system functions, and commands are given. General information on the ISCLT model and detailed descriptions of the SIM components are given. Finally, a case example is presented.

48052 (PB–89-179931/XAB) **Chesapeake bay basinwide toxics reduction strategy: an agreement commitment report from the Chesapeake Executive Council. Final report.** Environmental Protection Agency, Annapolis, MD (USA). Chesapeake Bay Program. Jul 1988. 37p. Available from NTIS, PC A03/MF A01.

See also PB–84-140508.

Outlines steps to be taken to work towards a toxics-free Chesapeake Bay by eliminating the discharge of toxic substances from all controllable sources. Commitments in the strategy are to ensure that by the year 2000 the input of toxic substances from all controllable sources to the Chesapeake Bay will be reduced to levels that result in no toxic or bioaccumulative impacts on the living resources that inhabit the Bay or on human health.

48053 (PB–89-182158/XAB) **Massachusetts lake classification program (revised). Final report.** Massachusetts Dept. of Environmental Quality Engineering, Westborough, MA (USA). Div. of Water Pollution Control. Jan 1984. 56p. Available from NTIS, PC A04/MF A01.

In accordance with Public Law 95-217, Section 314 (the 'Clean Lakes' section of the 1977 Amendments to the Federal Water Pollution Control Act), the Massachusetts Division of Water Pollution Control developed a lake classification program based upon the trophic condition of all publicly owned freshwater lakes and ponds in

the Commonwealth. This publication, produced and updated on an annual basis since 1976, is the result of that program.

48054 (PB–89-182406/XAB) **Superfund Record of Decision (EPA Region 9): MGM Brakes site, Cloverdale, California (first remedial action), September 1988. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1988. 206p. (EPA/ROD/R–09-88/018). Available from NTIS, PC A10/MF A01.

Portions of this document are not fully legible.

The MGM Brakes site consists of a five-acre plot containing an automotive brakes casting plant, a paved area surrounding the plant, and an open field. It is located in the community of Cloverdale, California, in Alexander Valley, approximately 80 miles north of San Francisco. From 1965 until 1972, hydraulic fluid containing PCBs was discharged onto site property. Waste water containing ethylene glycol was disposed onsite between 1972 and 1981. The ethylene glycol acted as a co-solvent with water, facilitating the transport of PCBs in soil. Approximately 13,510 cu yds of soil within a 3-acre area were contaminated with PCBs at concentrations up to 4500 ppm. The primary contaminants of concern affecting soil, sediments, surface water, and air are PCBs. The selected remedial action for the site includes: dismantling of the MGM Brakes process building; crushing of concrete slab, and excavation of soil. The estimated capital cost for the remedial action is $5,369,300 with no annual O&M costs.

48055 (PB–89-182448/XAB) **Superfund Record of Decision: (EPR Region 6): Curley Pit Site, ground-water operable unit, Crittenden County, Arkansas (second remedial action), September 1988. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 26 Sep 1988. 28p. (EPA/ROD/R–06-88/046). Available from NTIS, PC A03/MF A01.

The Gurley Pit site consists of a 3.25-acre pit located approximately one mile north of Edmondson, Crittenden County, Arkansas. The primary land use is agricultural. Gurley Refining Company (GRC) leased the site from R.A. Caldwell between 1970 and 1980. During this time the pit was divided by levees into three cells and used between 1970 and 1975 as a state permitted disposal site for secondary oil-refining wastes including acids, oil sludges, PCBs, inorganics and spent diatomaceous wastes. In May 1978, EPA and ADPCE received complaints of chronic overflows from storm runoff. These overflows had an adverse affect on fish and waterfowl in the Fifteen Mile Bayou. The selected source control remedy included treatment and discharge of onsite surface water, offsite incineration of PCB-contaminated oil, ground-water monitoring, and stabilization and onsite disposal of contaminated sludge, sediment, and soil.

48056 (PB–89-188528/XAB) **Response of the US EPA (Environmental Protection Agency) region 5 states to the nonpoint source reporting requirements of the 1987 Clean Water Act amendments. Technical report.** Hautman, N. Wisconsin Univ., Madison, WI (USA). Inst. for Environmental Studies. 1988. 87p. Available from NTIS, PC A05/MF A01.

This report attempts to determine the extent of nonpoint source pollution in Region V. The report analyzes and summarizes the nonpoint source and clean lakes reports required under the Clean Water Act amendments of 1987. The reports share common elements such as a focus on agricultural sources and the use of hard data as well as professional judgment. However, they differ in overall design, definitions of key elements, level of analysis, thoroughness, and effectiveness. The summary considers the reports from two aspects: structure and the extent to which they comply with Sec. 319 and U.S. EPA reports as they are constructed. Information in the 305 (b) reports adds to the scope of each state's nonpoint source program and is referred to here. Following the summary is a discussion, accompanied by appropriate tables, of the nonpoint source pollution extent.

48057 (PB–89-188932/XAB) **Superfund Record of Decision (EPA Region 1): Groveland Wells Nos. 1 and 2 Site, Valley site source-control organic operable unit, Groveland, Massachusetts (first remedial action), September 1988.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 30 Sep 1988. 242p. (EPA/ROD/R–01-88/030). Available from NTIS, PC A11/MF A01.

The 850-acre Groveland Wells site is located in the Town of Groveland, Essex County, Massachusetts within the lower Johnson Creek drainage basin. The site includes the watershed and aquifer which recharge two municipal supply wells, Station Nos. 1 and 2, and three known sources of soil, surface water, and ground-water contamination: the Valley site, the A.W. Chesterson site, and the Havenhill Municipal Landfill site. The selected remedial action for the Valley site operable unit includes: in-situ vacuum extraction of approximately 20,000 cu yds of unsaturated soil followed by activated-carbon treatment of the extracted VOCs; onsite groundwater pump and treatment by carbon adsorption and aeration, with recharge to the aquifer of a portion of the treated ground water.

48058 (PB–89-189633/XAB) **Needs survey report to Congress, 1988: assessment of needed publicly owned wastewater treatment facilities in the United States.** Environmental Protection Agency, Washington, DC (USA). Office of Municipal Pollution Control. Feb 1989. 70p. (EPA–430/09-89/001). Available from NTIS, PC A04/MF A01.

See also PB–87-157251.

This report provides EPA's detailed estimate of the capital costs to build publicly owned municipal waste-water treatment facilities to comply with the requirements of the Clean Water Act. The 1988 Needs Survey Focuses on construction-grant eligible category of need, rather than the expanded State Revolving Fund eligibilities under the 1987 Amendments to the Clean Water Act. EPA's needs estimates include those facilities for which a water quality or public-health problem could be documented in accordance with specific criteria established in the 1986 Survey.

48059 (PB–89-189724/XAB) **Federalism and the surface-water program. Technical report.** Hill, P.C. Virginia Univ., Charlottesville, VA (USA). Div. of Urban and Environmental Planning. 1988. 43p. Available from NTIS, PC A03/MF A01.

This report is part of the National Network for Environmental Management Studies (NNEMS) under the auspices of the Office of Cooperative Environmental Management of the U.S. Environmental Protection Agency. The report presents the results of a study of the impact of federalism on state surface-water programs. The study focuses on the historical pattern of federal funding and the impact of amendments to the Clean Water Act as they affect states' capacities to manage their surface-water programs. Information on financial funding patterns was obtained from three different accounting branches that monitor the Agency's expenditures. Information on legislative changes was derived from interviews with individual program directors and their personnel, as well as from research. In actual dollars, the surface-water program has lost 20% of its federal funding since 1980. In constant dollars, the surface water program has lost 43% of its federal funding since 1980, and amendments to the 1972 Clean Water Act (1972-1987) have basically brought the water-pollution-control program full circle.

48060 (PB–89-189740/XAB) **Improving state outreach to small communities. Technical report.** Livingston, B.L. California Univ., Berkeley, CA (USA). Graduate School of Public Policy. 12 Aug 1988. 46p. Available from NTIS, PC A03/MF A01.

This report is part of the National Network of Environmental Management Studies (NNEMS) under the auspices of the Office of Cooperative Environmental management and the U.S. Environmental Protection Agency. The report suggests several ways to improve outreach to small communities from EPA and the state in wastewater treatment development and maintenance. Outreach is the transfer of information, technology, and technical assistance. Outreach can reduce costs and improve performance at relatively low cost. There are five major recommendations to improve outreach. Moreover, the report describes funding sources, steps for implementation, an analysis of the benefits and costs of these recommendations, and the range of savings and costs. The author also presents a model of the 'current outreach delivery system' followed by an examination of common pitfalls to outreach. Finally, the author suggests an 'ideal outreach delivery model' for the fiscal years 1990 to 1994.

48061 (PB–89-190151/XAB) **Combined sewer overflow: A management study. Technical report.** Reilly, A. Yale Univ., New Haven, CT (USA). School of Forestry and Environmental Studies. 1988. 33p. Available from NTIS, PC A03/MF A01.

See also PB–85-180859.

This project is part of the National Network for Environmental Management Studies under the auspices of the Office of Cooperative Environmental Management of the U.S. Environmental Protection Agency. In many older cities in the U.S., the capacity of the combined sewer is exceeded on a daily basis due to both-wet weather storm surges and increased volumes of waste generated by new development. As a result, billions of gallons of untreated sewage are discharged on an annual basis into the nation's marine bays and estuaries in episodes called 'combined sewer overflow.' There are two primary reasons for the increasing frequency and severity of overflow episodes: the population of cities in coastal areas are growing at rates that far exceed the ability of the sewer infrastructure to accommodate them; the built-in inefficiencies of the original design of the combined sewer are being exploited by many municipalities to compensate for the increased volumes of sewage associated with the growth in population. Because each combined sewer, the area that it drains, and the receiving water into which it discharges constitutes a unique system, a management strategy should be site-specific. The document proposes a framework within which a site-specific and cost-effective management strategy may be formulated. By necessity, the emphasis is on providing tools and methods rather than explicit solutions.

48062 (PB–89-190300/XAB) **Wetlands and water quality: EPA's (Environmental Protection Agency's) research and monitoring implementation plan for the years 1989-1994.** Adamus, P.R. NSI Technology Services Corp., Corvallis, OR (USA). Apr 1989. 61p. Available from NTIS, PC A04/MF A01.

This document describes products which the US EPA Wetlands Research Program proposes to develop during the years 1989-1994. The general protocols used to develop these products are also described. All these products are intended to address concerns about the wetlands and water quality, and are part of a larger set of products EPA is developing to deal with other aspects of wetlands. EPA's highly interrelated concerns about wetlands and water quality can be generally categorized as follows: water quality criteria to protect wetland function; ecological status of the wetland resource; and waste-assimilation limits of wetlands.

48063 (PB–89-190409/XAB) **Wetlands and waste-water management: Questions, answers, advice, and guidance. Technical report.** Wernstedt, K. Environmental Protection Agency, Washington, DC (USA). Office of Cooperative Environmental Management. 1988. 178p. (EPA–600/9-89/028). Available from NTIS, PC A09.

Portions of this document are not fully legible.

This report focuses on the treatment or disposal of waste water in natural or constructed wetlands. Both natural and constructed wetlands may be able to meet some of the community's waste water disposal and/or treatment needs, but the final determination of the appropriateness of a specific discharge to a specific wetland rests on an individual, detailed site assessment. The document discusses a number of factors relevant to the assessment. The report comes in two versions: an Executive Summary for the municipal official or general reader and a full-length version, which may serve a more technical audience.

48064 (PB–89-192074/XAB) **Drinking-Water Criteria Document for Asbestos (final draft), March 1985.** Sonich-Mullin, C.; Patel, Y.; Bayard, S.; Mossman, B.T. Environmental Protection Agency, Cincinnati, OH (USA). Office of Environmental Criteria and Assessment. Mar 1985. 192p. Available from NTIS, PC A09/MF A01.

See also PB–86-118262.

The Office of Drinking Water (ODW), Environmental Protection Agency has prepared a Drinking Water Criteria Document on Asbestos. This Criteria Document is an extensive review of the following topics: Physical and chemical properties of Asbestos; Toxicokinetics and human exposure to Asbestos; Health Effects of Asbestos in humans and animals; Mechanisms of toxicity of Asbestos; Quantification of toxicological effects of Asbestos.

48065 (PB–89-192140/XAB) **Drinking-Water Criteria Document for Cadmium (final draft), December 1986. Final draft report.** Life Systems, Inc., Cleveland, OH (USA). Dec 1986. 318p. (TR–832-93). Available from NTIS, PC A14/MF A01.

See also PB–86-117934.

The Office of Drinking Water, Environmental Protection Agency has prepared a Drinking Water Criteria Document on Cadmium. The Criteria Document is an extensive review of the following topics: Physical and chemical properties of Cadmium; Toxicokinetics and human exposure to cadmium; health effects of cadmium in humans and animals; mechanisms of toxicological effects of cadmium; and quantification of toxicological effects of cadmium.

48066 (PB–89-192207/XAB) **Drinking-Water Criteria Document for inorganic mercury (final), July 1988.** Environmental Protection Agency, Cincinnati, OH (USA). Office of Environmental Criteria and Assessment. Jul 1988. 149p. Available from NTIS, PC A07/MF A01.

See also PB–86-117827.

The Office of Drinking Water, Environmental Protection Agency has prepared a Drinking Water Criteria Document on Mercury. The Criteria Document is an extensive review of the following topics: Physical and chemical properties of Mercury; toxicokinetics and human exposure to mercury; health effects of mercury in humans and animals; mechanisms of toxicological effects of mercury; and quantification of toxicological effects of mercury.

48067 (PB–89-192256/XAB) **Drinking-Water Criteria Document for polychlorinated biphenyls (PCBs) (final), April 1988.** Barsotti, D.A.; Olson, J.R.; Pellizzari, E.D.; Que Hee, S.S.; Safe, S.H. Environmental Protection Agency, Cincinnati, OH (USA). Office of Environmental Criteria and Assessment. Apr 1988. 436p. Available from NTIS, PC A19/MF A01.

The Office of Drinking Water, Environmental Protection Agency has prepared a Drinking Water Criteria Document on PCB. The Criteria Document is an extensive review of the following topics: Physical chemical properties of PCB; Toxicokinetics and human exposure to PCB; Health effects of PCB in humans and animals; Mechanisms of toxicological effects of PCB; and Quantification of toxicological effects of PCB.

48068 (PB–89-192264/XAB) **Drinking-Water Criteria Document for selenium (final draft), December 1986.** Life Systems, Inc., Cleveland, OH (USA). Dec 1986. 189p. (TR–832-89). Available from NTIS, PC A09/MF A01.

See also PB–86-118098.

The Office of Drinking Water, Environmental Protection Agency has prepared a Drinking Water Criteria Document on Selenium. The Criteria Document is an extensive review of the following topics: Physical and chemical properties of Selenium; Toxicokinetics and human exposure to selenium; Health effects of selenium in humans and animals; Mechanisms of toxicological effects of selenium; and quantification of toxicological effects of Selenium.

48069 (PB–89-192397/XAB) **Regulatory impact analysis: Benefits and costs of proposed National Primary Drinking Water Regulations for inorganic chemicals. Phase 2, March 1989.** Miller (Wade) Associates, Inc., Arlington, VA (USA). 31 Mar 1989. 102p. Available from NTIS, PC A06/MF A01.

National Primary Drinking Water Regulations are proposed for 30 synthetic organic chemicals, termed the SOCs. The document presents an analysis of the projected national costs and benefits associated with the proposed regulations in compliance with Executive Order 12291. It also includes an analysis of cost impacts on small water systems in compliance with the Regulatory Flexibility Act. The 30 SOCs fall into three groups. For a group of three 'miscellaneous' contaminants (acrylamide, epichlorohydrin, and PCBs), it is simply not possible to estimate occurrence due to a lack of data. Total national costs and benefits for all three are not anticipated to be very significant.

48070 (PB–89-192405/XAB) **Regulatory impact analysis of proposed National Primary Drinking Water Regulations for synthetic organic chemicals. Phase 2, April 1989.** Miller (Wade) Associates, Inc., Arlington, VA (USA). Apr 1989. 108p. Available from NTIS, PC A06/MF A01.

This report contains an analysis of the costs and benefits of controlling inorganic chemical contaminants (IOCs) in drinking water through the promulgation of regulations for maximum contaminant level goals (MCLGs) and maximum contaminant levels (MCLs). The regulatory impact analysis (RIA) was prepared in accordance with Executive Order 12291 which requires that the costs and benefits of all major rules be examined and compared. The major topical areas covered in the RIA are as follows: Problem definition; Market imperfections, the need for federal regulation, and consideration of regulatory alternatives; Assessment of total costs; Assessment of benefits; Regulatory flexibility and paperwork reduction analyses; and a summary of costs and benefits.

48071 (PB–89-192413/XAB) **Information-collection request for: National Primary Drinking Water Regulations for inorganic chemicals. Phase 2, March 1989.** Miller (Wade) Associates, Inc., Arlington, VA (USA). 31 Mar 1989. 35p. Available from NTIS, PC A03/MF A01.

The Environmental Protection Agency (EPA), under the requirements of the Safe Drinking Water Act Section 1401 and 1412, P.L. 99-339, as amended in 1986, has proposed a National Primary Drinking Water Regulation (NPDWR) pertaining to the contamination of public-water systems by inorganic chemical contaminants. The proposed IOCs Rule includes information collection requirements for eight inorganic chemicals – asbestos, barium, cadmium, chromium, mercury, nitrate, nitrite, and selenium. The information collection request analyzes the information burden imposed on public-water systems and States as a result of the regulation. EPA is proposing only to regulate source-related inorganics under this rule, as opposed to inorganics which predominately occur as corrosion by-products and naturally occurring copper and lead are analyzed in the RIA and ICR for lead and corrosion by-products. Note also that EPA has already promulgated a NPDWR for fluoride.

48072 (PB–89-192421/XAB) **Information collection request for proposed National Primary Drinking Water Regulations for synthetic organic chemicals (draft), April 1989.** Miller (Wade) Associates, Inc., Arlington, VA (USA). Apr 1989. 28p. Available from NTIS, PC A03/MF A01.

The Environmental Protection Agency (EPA), under the requirements of the Safe Drinking Water Act (Section 1401 and 1412, P.L. 99-339, as amended in 1986), has proposed National Primary Drinking Water Regulations (NPDWR) pertaining to the contamination of public water systems by synthetic organic chemical (SOCs) contaminants. The proposed regulations require the collection of information by public water systems, states, and the EPA. Information collection requirements include monitoring, reporting, and record-keeping activities that are discussed in this Information Collection Requests (ICR) document.

48073 (PB–89-195234/XAB) **Guidelines and requirements for applying for grants from the Indian set-aside program.** Gesalman, C.M.; Mallon, G.M. Environmental Protection Agency, Washington, DC (USA). Apr 1989. 66p. Available from NTIS, PC A04/MF A01.

These guidelines were prepared to help Indian tribes apply for and manage the grants for the construction of waste-water facilities that are available from the U.S. Environmental Protection Agency under Section 518(c) of the Clean Water Act. Some aspects of the program for Indian tribes are somewhat different and more flexible than the Construction Grants Program, which has funded grants to municipalities under State priority systems since 1972. The Indian Set-Aside Program simplifies administrative requirements. However, existing Construction Grants program materials will be used to the extent they are compatible with these guidelines.

48074 (PB–89-195242/XAB) **Ambient water-quality criteria for ammonia (salt water)-1989.** Environmental Protection Agency, Washington, DC (USA). Criteria and Standards Div. Apr 1989. 85p. (EPA–440/5-88/004). Available from NTIS. PC A05/MF A01.

See also PB–85-227114.

Ammonia is a common and highly toxic pollutant which, in sufficient quantities, will adversely affect aquatic organisms. This ammonia criteria document for salt water will ailow establishment of regulatory standards for ammonia discharge into estuaries, near coastal zones and oceans. Possible adverse impacts in highly sensitive and abundant ecosystems such as estuaries make regulation particularly important.

48075 (PB–89-196695/XAB) **Superfund Record of Decision (EPA Region 5): Republic Steel Quarry Site, Elyria, Ohio (first remedial action), September 1988. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 30 Sep 1988. 44p. (EPA/ROD/R–05-88/084). Available from NTIS, PC A03/MF A01.

The Republic Steel Quarry site is located in the City of Elyria in Lorain County, Ohio, southwest of Cleveland. From 1950 to 1972, approximately 200,000 gallons of waste pickle liquor (acid wastes used in steel processing) were discharged to a ditch located on the east side of the steel plant, which flowed north into the quarry. From 1972 to 1975 the ditch was used for disposing of rinse water from pickling operations. The primary contaminants of concern affecting surface water, sediments, and soil are VOCs including toluene, and metals including chromium and lead. The selected remedial action for this site includes: excavation and offsite disposal an a RCRA landfill of approximately 100 cu yds of contaminated surface soil from the pickle-liquor discharge ditch and from along the southern end of the quarry; and implementation of a five-year monitoring plan including a fish-species survey.

48076 (PB–89-196703/XAB) **Superfund Record of Decision (EPA Region 5): Velsicol Chemical Corporation, Marshall, Illinois (first remedial action), September 1988. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 30 Sep 1988. 98p. (EPA/ROD/R–05-88/081). Available from NTIS, PC A05/MF A01.

The Velsicol Chemical Corporation (VCC) is a manufacturing facility located in east-central Illinois, approximately one mile north of the City of Marshall, Clark County, Illinois. A total of 334 acres onsite are leased for crop farming. VCC was in operation between the mid-1930s and August 1987, and occupied an area of approximately 420 acres, 172 of which were used for production or disposal practices for petroleum derivatives including resins, solvents, and pesticides, including chlordane manufacturing. All process waste water has been deep-well injected onsite since 1965 and the majority of the waste solids and sludges generated at the facility were disposed of in Pond 5/6 until 1980 when the firm ceased operations. Accidental and intentional offsite releases of wastes were noted during the period the ponds were in operation. In the 1980s, all contaminated soil and visually contaminated sediments were consolidated and stabilized with cement and fly ash, and covered with a temporary clay cap and vegetation. The primary contaminants of concern affecting the soil, sediments, surface water and ground water are VOCs including benzene and other organics including PAHs and pesticides. The selected remedial action for the site is included.

48077 (PB–89-196711/XAB) **Superfund Record of Decision (EPA Region 4): Flowood, Rankin County, Mississippi (first remedial action), September 1988. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 30 Sep 1988. 51p. (EPA/ROD/R–04-88/041). Available from NTIS, PC A04/MF A01.

The Flowood site consists of 225 acres of mostly wetlands and lowlands, is located in the Town of Flowood, Rankin County, Mississippi on the east side of the Pearl River. The site includes waste-water discharge areas and downstream areas adjacent to two industrial manufacturing facilities. Two manufacturing facilities have been owned and operated by a series of companies at the Flowood site since the 1950s. The northernmost facility manufactured corrugated boxes, and the southernmost facility produced ceramic tiles through the 1970s and stoneware cooking pots from the mid-1970s to the present. A routine industrial wastewater inspection conducted by the Mississippi Department of Natural Resources (MDNR) in the fall of 1982 revealed the unpermitted discharge of hazardous substances to the onsite canal. Subsequent sampling detected lead contamination in water and sediments from the canal. The MDNR began an emergency treatment and removal process to address the contaminated waste-water, but discontinued the process when higher levels of lead were found in the canal adjacent to one of the manufacturing sites. In 1983, EPA investigations revealed high lead levels in onsite sludges, sediments, and

surface soil. The primary contaminant affecting the soil and sediments is lead. The selected remedial action for the site is included.

48078 (PB–89-196729/XAB) **Superfund Record of Decision (EPA Region 4): Celanese Fibers Operations, Shelby, North Sarolina (first remedial action), March 1988.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 23 Mar 1988. 79p. (EPA/ROD/R–04-88/038). Available from NTIS, PC A05/MF A01.

The 450-acre Celanese Fiber Operations (CFO) site is occupied by a polyester raw-material production facility and is located in Cleveland County, one mile north of Earl, North Carolina. The plant began operations in 1960 as Fibers Industries, Inc. and manufactured polyester polymer chip and filament yarn using the chemicals dimethyl terephthalate and ethylene glycol. The CFO waste-treatment plant was constructed in phases concurrent with the manufacturing plant. This resulted in the disposal of chemical wastes directly into a drainage ditch during the early years of operation prior to completion of the waste-treatment plant. Several areas around the plant have been used for waste disposal, including old burning pits for normal plant wastes (polyester and trash), a glycol recovery-unit sludge-burial area, and a former drum storage and staging area (drums contained solutions that failed to polymerize) excavated and backfilled in the mid-1960s, and two soak-away ponds formerly containing treated sanitary sewage. The primary contaminants of concern affecting the ground water include: VOCs including benzene and PCE, organics including phenols, and metals including chromium. The selected remedial action for the site is included.

48079 (PB–89-196737/XAB) **Superfund Record of Decision (EPA Region 3): Drake Chemical Site, Lock Haven, Pennsylvania (third remedial action), September 1988. Final report.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 29 Sep 1988. 98p. (EPA/ROD/R–03-88/058). Available from NTIS, PC A05/MF A01.

See also PB–87-188454.

The Drake Chemical Site (DCS) is a 12.5-acre inactive chemical manufacturing facility located in Lock Haven, Clinton County, Pennsylvania. The DCS facility includes two synthetic-lined waste-water treatment lagoons, an unlined leachate lagoon, and a dry unlined sludge lagoon. The water and sediments within the two lined impoundments are highly contaminated with site-related organic and inorganic contaminants. The site surface is covered with debris, chemical sludge, and contaminated soil. Approximately 252,000 cu yds of soil, sludges and sediments are contaminated. The Drake Chemical Company was cited several times by State and Federal agencies for violating environmental and health and safety regulations. The focus of the ROD is remediation of the contaminated soil, sludges, and ground water at the site. The primary contaminants of concern affecting the ground water, surface water, soil, and sediments are VOCs including benzene, toluene, TCE, and xylenes, other organics including fenac, phenols, and PAHs, and metals including lead, chromium, and arsenic. The selected remedial action for the site is included.

48080 (PB–89-204754/XAB) **Superfund Record of Decision (EPA Region 1): Old Springfield Landfill, Vermont (first remedial action), September 1988.** Environmental Protection Agency, Washington, DC (USA). Office of Emergency and Remedial Response. 22 Sep 1988. 215p. (EPA/ROD/R–01-88/033). Available from NTIS, PC A10/MF A01.

The Old Springfield Landfill site is located approximately one mile southwest of the city center in Springfield, Windsor County, Vermont. Four areas of contamination have been identified at the site where industrial waste was either disposed of in discrete trenches or mixed with the municipal waste. The primary contaminants are VOCs including benzene, PCE, TCE, toluene, and other organics including PCBs and PAHs. The selected remedial action for this site includes: construction of an underground collection system to collect leachate; installation of wells for extraction of contaminated ground water; onsite treatment of the collected leachate and extracted ground water.

53 ENVIRONMENTAL–SOCIAL ASPECTS OF ENERGY TECHNOLOGIES

5302 Assessment of Energy Technologies

48081 (AD-A–207201/5/XAB) **Draft Environmental Impact Statement. Peacekeeper Rail Garrison Program. Executive summary.** Department of the Air Force, Washington, DC (USA). Jun 1988. 54p. Available from NTIS, PC A04/MF A01.

The U.S. Air Force proposes to deploy 50 Peacekeeper missiles on 25 trains, which will be based at F.E. Warren AFB, Wyoming, and at up to ten other garrison installations. If the Peacekeeper Rail Garrison system is approved for deployment, F.E. Warren AFB would be the Main Operating Base (MOB) and the first garrison installation. After the Final EIS is filed, the other garrison installations to be used would be selected from the ten candidates and the decision would be documented in one or more Records of Decision. Up to four trains could be deployed at each selected garrison installation. Peacekeeper missiles would be assembled and integrated onto the missile launch cars at F.E. Warren AFB and then dispatched to other selected garrison installations. Potential environmental impacts associated with both of these actions are considered in the DEIS under the following environmental resource categories: socieoconomics, utilities, transportation, land use, cultural, biological, water, geology and soils, air quality, and noise. In addition, national economic impacts, national railroad transportation impacts, and safety considerations are discussed. Finally, mitigation measures that can be taken to rehabilitate or restore the affected environment or to reduce significant adverse impacts are identified.

48082 (OCS/EIS/EA/MMS–89-0053) **Gulf of Mexico Sales 123 and 125: Central and Western Planning Areas: Final Environmental Impact Statement.** Minerals Management Service, New Orleans, LA (USA). Gulf of Mexico OCS Regional Office. Aug 1989. 539p. Sponsored by U.S. Department of the Interior. Available from OSTI; US Department of Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA 70123-2394.

The Environmental Impact Statement (EIS) covering the proposed OCS oil and gas lease sales in the Gulf of Mexico for 1990 is a product of the Minerals Management Service (MMS) in New Orleans, Louisiana. This document discusses the purpose and background of the proposed actions, the alternatives including the proposed actions, the description of the affected environment, and the environmental impacts of proposed Central Gulf of Mexico Sale 123 (March 1990) and Western Gulf of Mexico Sale 125 (August 1990). This document makes reference to previous Final Environmental Impact Statements (Final EIS's) starting with the Final Regional EIS and seven intervening Final EIS documents. The most commonly referenced documents are the Final EIS's for the 1988 lease sales (Final EIS 113/115/116) and the Final EIS for the 1989 lease sales (Final EIS 118/122). Also referenced frequently are Visuals Nos. 2–7, which were last distributed with the EIS for Sales 113/115/116 (Visual No. 1 has been updated and is included with this document). Copies of these documents and visuals may be obtained from the MMS, Gulf of Mexico OCS Region, 1201 Elmwood Park Blvd., New Orleans, Louisiana 70123-2394 or may be viewed at any of the EIS depository libraries listed on the back of Visual No. 1.

48083 (OCS/EIS/EA/MMS–89-0061) **5-year outer continental shelf oil and gas leasing program, Mid-1987 to Mid-1992: Supplemental environmental impact statement: Draft.** Minerals Management Service, Herndon, VA (USA). Aug 1989. 167p. Sponsored by U.S. Department of the Interior. Available from OSTI - US Dept. of Interior, Minerals Management Serv., 381 Elden St., Herndon, VA 22070.

This draft document supplements the final environmental impact statement prepared for the 5-Year (Mid-1987 to Mid-1992) Outer Continental Shelf (OCS) oil and gas leasing schedule. This document analyzes the cumulative impacts of OCS development on migratory species whose migration routes traverse more than one planning area in the Alaska and Pacific Regions. The analysis is based on the court's premise that the Secretary did not consider the effects of simultaneous inter-regional development on migratory species. It also describes and incorporates into the analysis the

OCS oil and gas activities and non-OCS activities along those migration routes. The overall cumulative impacts on migratory species could be caused by oil and gas activities, oil spills, effluent discharges, noise (aircraft and vessel traffic and human disturbances), loss of habitat, subsistence and sport hunting, and natural perturbations. Coastal States which are considered in the analysis are: Alaska, Washington, Oregon, and California.

55 BIOMEDICAL SCIENCES, BASIC STUDIES

5501 Behavioral Biology

Refer also to citation(s) 47638

5502 Biochemistry

Refer also to citation(s) 47460, 47461, 47530

48084 (AD-A–207390/6/XAB) **Isolating a cell maximally secreting acetylcholinesterase. Annual report, 31 January 1984-30 January 1985.** Rose, S.; Von Wedel, R.J.; Dorian, R.; Scott, M.C.; Mighetto, P.I. Bio-Response, Inc., Hayward, CA (USA). Apr 1985. 45p. Available from NTIS, PC A03/MF A01.

Basic methods were developed for the isolation of subpopulations of cells which are high producers of a desired secreted cell protein. The ultimate goal of this research is to isolate a cell line maximally secreting human acetylcholinesterase (AChE, acetylcholine hydrolase). This positive selection system, termed the Cell Isolation Technique (CIT), has evolved in two different directions to screen individual cells trapped within agarose beads. Both approaches rely on a specific ligand-receptor antigen-antibody interaction to capture the desired secreted protein and immobilize it within the beads. In both cases, the cells secrete product, product binds to immobilized specific reagents and thus accumulates within the beads. Beads with high densities of desired product are identified and physically isolated so as to enrich for subpopulations of high producer cells. The two approaches differ with respect to how they identify and sort the beads with desired cells. In the original method, simple density gradient centrifugation is sufficient to separate beads with lysed red blood cells from the vast majority of beads with intact cells. The second approach uses a fluorescence activated cell sorter to screen beads which have accumulated captured secreted cell product now identified with fluorescently labeled antibodies. Although a cell line secreting high levels of AChE has not yet been developed by these methods, model studies have been encouraging. This report will therefore focus on the basic research behind this technology and its application for screening cells transfected with total genomic human DNA.

48085 (AD-A–208149/5/XAB) **Radioimmunoassay for pyridostigmine.** Meyer, H.G.; Lukey, B.J.; Gepp, R.T.; Corpuz, R.P.; Lieske, C.N. Army Medical Research Inst. of Chemical Defense, Aberdeen Proving Ground, MD (USA). 1988. 8p. (USAMRICD-P–88-004). Available from NTIS, PC A02/MF A01.

Pub. in the Jnl. of Pharmacology and Experimental Therapeutics, Vol. 247, No. 2, 432-438(1988).

Pyridostigmine is a cholinergic drug used for the treatment of myasthenia gravis and for antagonizing the effects of non-depolarizing muscle relaxants. In addition, military organizations in several countries have an active interest in pyridostigmine as a pretreatment compound for nerve agent poisoning. Anti-pyridostigmine antibodies were produced in rabbits using a pyridostigmine analog conjugated to keyhole limpet hemocyanin. These antibodies were used for development of a radioimmunoassay that has a linear standard curve (r2=0.986) ranging from 0.5 to 10.0 ng/ml of pyridostigmine bromide in a 0.1-ml plasma sample. This assay measures pyridostigmine in plasma with better sensitivity and much greater through-put than do current state-of-the-art high-performance liquid chromatography techniques. In addition, only small volumes (100ml) of the plasma samples are required. Plasma levels of pyridostigmine were determined in the rat after intramuscular administration (0.056mg/kg) of pyridostigmine bromide. Estimates of the various pharmacokinetic parameters were calculated using the computer program NONLIN84. The results were as follows: apparent volume of distribution = 1.97 1/kg, absorption rate constant = 0.277 min-1, elimination rate constant = 0.0273 min-1, area under the curve = 1010 ng x min/ml, absorption rate half-life = 2.41 min, elimination rate half-life = 24.8 min, maximal plasma concentration (Cmax) = 21.3 ng/ml and time to Cmax = 9.02 min.

48086 (DOE/ER/60305–T1) **Spontaneous genomic instability in humans: Final report.** Comings, D.E.; Kovacs, B. City of Hope National Medical Center, Duarte, CA (USA). [1989]. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract FG03-85ER60305. Order Number DE89015548/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The primary goal of this research was to determine if DNA techniques could be used to investigate spontaneous and radiation induced germinal mutation rates in man. The usual approach is to examine a large number of loci with low mutations rates, in a large numbers of individuals. The Japanese atomic bomb survivor studies have not shown significantly increased germinal mutation rates in those individuals exposed to radiation. This may be due to relative radiation resistance, low levels of radiation in most subjects, or to the insensitivity of the techniques. An alternative approach is the examination in a small number of individuals of a small number of loci each of which show very high germinal mutation rates. We have demonstrated the practical feasibility of this approach.

48087 (DOE/ER/60638–1) **Study of structure-function relationships in proteins: Techniques and applications of cytochrome c: Final report January 15, 1988–January 14, 1989.** Goldstein, D.A.; Rackovsky, S.R. Rochester Univ., NY (USA). School of Medicine and Dentistry. Aug 1989. 135p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-88ER60638. Order Number DE89016560/JAW. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

During the initial period of this work we explored the differential geometry results which had been used to explain the structure-function relationships in the set of yeast iso-1-cytochrome c mutants studied under the initial contract. In addition we continued the development of techniques which would permit the structural characterization and comparison of proteins in a very efficient manner. We have expanded the studies based on the characterization of the structural preferences of various residues in a sample of twenty six globular proteins. It has been demonstrated that the overall structural preferences and the amino acid specific preferences seen in the analysis carried out at the five alpha carbon level can not be explained by the results of the analysis carried out at the four alpha carbon level. Thus the structural preferences seen must be described by considering groups of five or more residues. We do no yet have enough data to extend the analysis to the six alpha carbon unit level. We have also verified that the yeast/tuna structural analogy which we used before was justified, and have performed a conformational energy minimization of the reduced yeast cytochrome c crystal data in order to have a baseline for the study of mutant proteins. 6 refs.

48088 (ORNL/FTR–2973) **[Collaborative research on the tumor antigen TSP-180]: Foreign trip report, July 1–17, 1988.** Kennel, S.J. Oak Ridge National Lab., TN (USA). 26 Jul 1988. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017430/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler spent five days in the Regina Elena Institute to have general discussions on research projects with several investigators. Detailed discussions of ongoing collaborative research were held with Drs. Ada Sacchi and Rita Falcioni.

48089 (ORNL/FTR–2976) **[Studies on the mechanism of insulin control of gene expression]: Foreign trip report, July 8–19, 1988.** Kenney, F.T. Oak Ridge National Lab., TN (USA). 27 Jul 1988. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017429/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler attended the International Congress and presented a paper entitled "Studies on the Mechanism of Insulin Control of Gene

Expression". Papers of particular interest to ORNL biochemists included a large number focusing on gene expression in eucaryotic cells and its regulation by hormones and other effectors, several concerned with molecular genetics of retroviruses, and many dealing with mechanisms of enzyme catalysis and protein turnover.

48090 (ORNL/FTR–3190) **[Endogenous retrotransposable gene elements af human genome in high incidence cancers]: Foreign trip report, December 6, 1988–March 6, 1989.** Yang, Wen K. Oak Ridge National Lab., TN (USA). 17 Mar 1989. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017382/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler worked full time for 3 months at the new biomedical research institute of Academia Sinica to investigate the presence of mobile gene elements (retrotransposons and/or endogenous retroviral genes) in Chinese patient-derived hepatomas, nasopharyngeal cancers and cervical cancers. The research project, taking advantage of the traveler's unique expertise in this field of research and the collections of unique cancer cell/tissue materials at IBMS, is important for the development of a unique research project of human genome studies at ORNL. The traveler was successful in preparing five cDNA libraries of the Chinese patient origin (two from hepatomas and one each from nasopharyngeal cancer, cervical cancer and pituitary tumor); in obtaining preliminary results of human cancer cell poly(A) RNAs with tRNA primer binding and reverse transcription activities; in collecting cancer and normal chromosomal DNA materials from Chinese patients; and in establishing contacts for possible collaborative clinical and epidemiological investigation.

48091 (ORNL/FTR–3238) **[Regulation of tetrahydropterins in Drosophila: Research review]: Foreign trip report, April 5, 1989–May 5, 1989.** Jacobson, K.B. Oak Ridge National Lab., TN (USA). 10 May 1989. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017384/JAW. Available from NTIS, PC A02/MF A01 · OSTI; GPO Dep.

The traveler spent eighteen days in the Department of Genetics of the University of Valencia, Valencia, Spain, to perform collaborative research, to outline a final report to the above committee, to prepare abstracts and publications, to consult with staff members and students and to present a lecture. Newly developing research projects among member countries of the European Economic Community were also discussed.

48092 (PB–89-167936/XAB) **Research and development in biotechnology-related industries in Japan (1989).** Mosbacher, R. International Trade Administration, Washington, DC (USA). 1989. 63p. Available from NTIS, PC EE04/MF A01.

See also PB–89-141147.

This report is based on observations made by the author as the officer in charge of the biotechnology program in the Foreign Commercial Service at the American Embassy in Tokyo during 1985 through 1986, and by the reviews of various biotechnology-related Japanese publications during 1986 through 1988. Activities of private industry and the Japanese government role in assisting industry are discussed in detail, followed by the brief descriptions of all major companies and laboratories in Japan active in biotechnology. Specific mention is made of the Japanese government's Human Frontier Program to encourage international cooperation in biotechnology research. Finally, tables are provided to show biotechnology products commercialized during 1987 and R and D activities that made news during 1987, which indicate the typical Japanese trait of doing many things a little at a time - persistently working toward a set goal.

48093 (PB–89-184055/XAB) **Studies on glass support for DNA synthesis.** Imada, K.; Shima, K.; Kusano, K.; Nakashima, T.; Tsutsumi, N. Asahi Glass Co. Ltd., Yokohama (Japan). Research Lab. 1988. 10p. Available from NTIS, PC EE12/MF A01.

Text in Japanese. Included in Reports of the Asahi Glass Foundation for Industrial Technology, Vol. 53, 235-243(1988).

Merrifield type support deoxyribonucleic acids (DNA) synthesizer was produced with porous glass based on the composition and procedure proposed by Nakashima, Miyazaki prefecture, (Sirasu porous glass; SPG) which contains some quantities of aluminum whereas so called CPG type porous glass, based on the patents from Corning Co., etc., contains at their final state only silicon oxide and boron. DNA was synthesized successfully, with slightly depressed yield, and consequently, contamination of shorter oligonucleotide possibly due to the activeness of the surface of SPG in comparison with CPG. Optimization of the pore diameters, surface densities of reaction spots, and the length of spacer arm of the reaction site was effected. The pore diameters around 1000 Angstroms, and a lower amine functionality on the glass surface, such as 5 micro mol/sq m, gave a good yield of DNA. Two types of amine compounds of different chain lengths examined as spacer arms gave no differences.

48094 (UCRL–101588) **Multiple endpoints for somatic mutations in humans provide complementary views for biodosimetry, genotoxicity, and health risks.** Jensen, R.H.; Bigbee, W.L.; Langlois, R.G. Lawrence Livermore National Lab., CA (USA). 24 Jul 1989. 12p. Sponsored by DOD;DOHHS. DOE Contract W-7405-ENG-48. CA48518;DNA89-869. (CONF-8907113–7: 5. international conference on environmental mutagens, Cleveland, OH (USA), 10-15 Jul 1989). Order Number DE89016577/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

There are now four somatic cell mutation assays that are being used to determine in vivo mutagenesis in humans. Each assay is identified by an acronym that specifies the protein in which mutations are determined: HPRT assay, GPA assay, HLA assay, and Hb assay. Potentially, each assay can be used for either of two important applications; biodosimetry or cancer risk estimation. Biodosimetry is a means for determining the amount of exposure of an individual to a toxic agent by measuring the biological effect on the individual who was exposed. Based on the observation that many toxic chemicals and ionizing radiation are mutagenic to cells in culture and also to animals, the somatic mutation assays also should serve as biodosimeters for exposure of humans to these genotoxic phenomena. These four somatic mutation assays should contribute to the possibility of estimating each individual's risk of developing cancer by monitoring for the presence of genotoxicity events similar to cancer initiation events or cancer promotion events on suppressor genes. 16 refs., 4 tabs.

48095 **Radioactive-electrophoretic assay of adenosine 5'-triphosphate sulfurylase activity in crude extracts with sulfate or selenate as a substrate.** Hanna, M.L. (Lawrence Livermore National Lab., CA (USA)); Taylor, R.T. *Analytical Biochemistry (USA)*, 176(2): 294-302 (1 Feb 1989).

An assay method for ATP sulfurylase is presented which employs $Na_2(35)SO_4$ as a substrate and measures the production of labeled adenosine 5'-phosphosulfate and 3'-phosphoadenosine 5'-phosphosulfate by low-voltage, hanging paper strip electrophoresis. The method is applicable to crude bacterial or mammalian extracts and accurately measures picomole amounts of product(s). $Na_2(^{75})SeO_4$ can also be employed as a substrate, if the unstable radioactive product, adenosine 5'-phosphoselenate, is converted to elemental ^{75}Se degrees by inclusion of reduced glutathione in the reaction mixture. The same paper strip electrophoretic technique can then be used to separate ^{75}Se degrees from the radiolabeled substrate. The method also has utility for measuring any direct reduction by crude microbial extracts of radioactive selenate to selenite, independent of ATP sulfurylase.

48096 **Examination of the function of active site lysine 329 of ribulose-bisphosphate carboxylase/oxygenase as revealed by the proton exchange reaction.** Hartman, F.C. (Oak Ridge National Lab., TN (USA)); Lee, E.H. *Journal of Biological Chemistry (USA)*, 264(20): 11784-11789 (15 Jul 1989).

Diverse approaches that include site-directed mutagenesis have indicated a catalytic role of Lys-329 of ribulosebisphosphate carboxylase/oxygenase from Rhodospirillum rubrum. To determine whether Lys-329 is required for the initial enolization of ribulose bisphosphate or for some subsequent step in the overall reaction pathway, the competence of position 329 mutant proteins (devoid of carboxylase activity) in catalyzing exchange of solvent protons with the C-3 proton of substrate has now been examined. Irrespective of the amino acid substitution for Lys-329, the mutant protein retains 2-6% of the wild-type activity in the proton exchange reaction. The complete stability of ribulose bisphosphate during the enolization

catalyzed by mutant protein suggests that the major effect of Lys-329 is to facilitate the addition of gaseous substrates (CO_2 or O_2) to the enediol intermediate. The exchange reaction requires Mg^{2+}, is CO_2-dependent, and is inhibited by the transition-state analogue 2-carboxyarabinitol 1,5-bisphosphate. A mutant protein in which Lys-191, the site for carbamylation by CO_2 in an obligatory activation step, is replaced by a cysteinyl residue totally lacks proton exchange activity. Barely detectable exchange activity (approximately 0.2% of wild-type) is displayed by the Lys-166—Cys mutant protein, consistent with the previously implicated role of Lys-166 in the deprotonation of ribulose bisphosphate. Retention of exchange activity by the Glu-48—Gln mutant protein, which is slightly active in overall carboxylation, demonstrates that active site Glu-48, like Lys-329, exerts its major effect at some step subsequent to the initial enolization.

5503 Cytology

48097 (ORNL/FTR–2978) **[Meeting of the Society for Cryobiology]: Foreign trip report, July 8–27, 1988.** Mazur, P. Oak Ridge National Lab., TN (USA). 9 Aug 1988. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017412/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The 25th Annual Meeting of the Society for Cryobiology was attended by some 225 scientific registrants, about double the usual members in US meetings. About half of the 227 presented papers were of US and UK origin. The People's Republic of China ranked a surprising fourth in the number of papers presented. The scientific quality of the papers was in general very high and many were mechanistically oriented. My contributions and main interest fall into two areas. One area is the question of whether slowly frozen cells are primarily injured by changes in the composition of the unfrozen channels in which they lie or by decreases in the size of the channels, which increase the probability of cell-ice and cell-cell contacts. The subject was formally debated at the meeting with me as the proponent of a major role for the unfrozen fraction and Dr. David Pegg as opponent. A number of presented papers (including two of our own) were relevant to the matter. My second main area of interest was in the cryobiology of Drosophila embryos. The ability to freeze eggs of this insect would be of considerable importance to Drosophila geneticists.

48098 **Improved DNA amplification technique.** Silveer, J. To Department of Health and Human Services, Washington, DC. USA Patent A 7-292,814. 3 Jan 1989. 30p. Available from NTIS, PC A03/MF A01.

This Government-owned invention available for U.S. licensing and, possibly, for foreign licensing. Copy of application available NTIS.

A modification of the polymerase chain reaction (PCR) technique is described. The method allows the amplification of regions of DNA flanking a single region of known sequence, in contrast to standard PCR which requires two regions of known sequence at opposite ends of the fragment to be amplified. Various advantages of the new method are described.

5504 Genetics

48099 (AD-A–207593/5/XAB) **Selectable sets of novel proteins: catalytic and other properties. Final report, 1 July-30 September 1988.** Kauffman, S.A. Pennsylvania Univ., Philadelphia, PA (USA). Dept. of Biochemistry. 8 May 1989. 9p. Available from NTIS, PC A02/MF A01.

This proposal aimed at the development of mathematical, computer, recombinant DNA, selection and screening procedures to attain adaptive evolution of entirely novel peptides or fusion proteins with useful catalytic, ligand binding, structural, or other features. Potential uses range from industrial catalysis to production of new drugs and vaccines. A broad purpose of the experimental effort is to obtain novel peptides that can mimic the biological effects of almost arbitrary signal molecules such as hormones, growth factors, even pathogenic antigens. Mathematical models were developed to explore rugged 'adaptive landscapes' associated with protein evolution. The fundamental importance of this work includes analysis of the distribution of function in peptide space and opening the way towards a technology of applied molecular evolution.

5506 Medicine

Refer also to citation(s) 47013, 48126

48100 (CEA-CONF–9774) **Progress in stable isotope analysis and new possibilities of clinical investigations.** Roth, E. CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Dept. de Physico-Chimie. 1989. 28p. (CONF-8901161–: 2. international symposium on new trends in chemistry: the role of analytical chemistry in national development, Le Caire (Egypt), 2-7 Jan 1989). Order Number DE90701461/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

The use of stable isotopes in medicine rests on three possibilities offered by labelling: identification of an element, a molecule, or a fragment of a molecule along its biological pathway; quantification of biological pools by isotopic dilution; measurement of metabolization rates, and more generally of clearances. Whenever a corporal function experiences a disregulation reflected either by changes in metabolic activity or modifications of the importance of pools of certain molecules, the possibility exists of making use of isotopes in diagnosis. Examples of practical applications of stable isotopes are given and analytical problems that had to be solved are underlined.

48101 (CONF-8905197–1) **Target-specific binding of immunoliposomes in vivo.** Holmberg, E.; Maruyama, K.; Kennel, S.; Klibanov, A.; Torchilin, V.; Ryan, U.; Huang, L. Oak Ridge National Lab., TN (USA). 1989. 31p. Sponsored by DOE/ER;DOHHS. DOE Contract AC05-84OR21400. CA24553. From 4. Princeton liposome conference; Princeton, NJ (USA); 15-16 May 1989. Order Number DE89015352/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Our group at the University of Tennessee has been concentrating on using monoclonal antibody for targeting of a liposomal drug carrier system. This paper discusses our initial effort to target these liposomes using an organ-specific monoclonal antibody. 9 refs., 9 figs.

48102 (CONF-8906203–1) **Platelet thrombosis in cardiac-valve prostheses.** Dewanjee, M.K. Miami Univ., FL (USA). School of Medicine. 1989. 35p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER60728. From International symposium on platelet-vessel wall interaction; Lubeck (Germany, F.R.); 8-9 Jun 1989. Order Number DE89015375/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The contribution of platelets and clotting factors in thrombosis on cardiovascular prostheses had been quantified with several tracers. Thrombus formation in vivo could be measured semiquantitatively in animal models and patients with indium-111, Technetium-99m labeled platelets, iodine-123, iodine-131 labeled fibrinogen, and In-111 and Tc-99m labeled antibody to the fibrinogen-receptor on the platelet- membrane, or fibrin. The early studies demonstrated that certain platelet-inhibitors, e.g. sulfinpyrazone, aspirin or aspirin- persantine increased platelet survival time with mechanical valves implanted in the baboon model and patients. Thrombus localization by imaging is possible for large thrombus on thrombogenic surface of prosthesis in the acute phase. The majority of thrombus was found in the sewing ring (Dacron) in the acute phase in both the mechanical and tissue valves. The amount of retained thrombus in both mechanical and tissue valves in our one-day study in the dog model was similar (< 1% if injected In-111 platelets = 5 billion platelets). As the fibrous ingrowth covered the sewing ring, the thrombus formation decreased significantly. Only a small amount of thrombus was found on the leaflets at one month in both the dog and calf models. 38 refs., 9 figs., 5 tabs.

48103 (INIS-mf–11515, pp. 46) **Irradiation planning by video digitalization.** Schachner, J. (Atominstitut der Oesterreichischen Universitaeten, Vienna (Austria)); Kallinger, W.; Aiginger, H. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society*. Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48104 (INIS-mf–11515, pp. 49) **PACS image archiving and -communication in radiology.** Gell, G. (Graz Univ. (Austria). Radiologische Klinik); Wiltgen, M. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48105 (INIS-mf–11515, pp. 50) **Staircase-shaped test phantom for control of image quality in veterinary medicine.** Parisot, M. (Veterinaermedizinische Univ., Inst. fuer Medizinische Physik, Vienna (Austria)); Keck, G. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48106 (INIS-mf–11515, pp. 50) **PC-supported measuring data recording and flow planning in radiological quality assurance.** Nowotny, R. (Vienna Univ. (Austria). Inst. fuer Radiumforschung und Kernphysik). Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48107 (INIS-mf–11515, pp. 52) **NMR imaging of the high-frequency field.** Stollberger, R. (Graz Univ., Inst. fuer Physik und Biophysik, Graz (Austria)); Wach, P.; Justich, E. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48108 (INIS-mf–11515, pp. 47) **Simultaneous application of irradiation and hyperthermia for tumor therapy.** Handl-Zeller, L. (Vienna Univ. (Austria). Klinik fuer Strahlentherapie und Strahlenbiologie); Schmidt, W.; Schreier, K.; Handl, O. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48109 (INIS-mf–11515, pp. 47) **Brachytherapy with I-125: a novel implantation system.** Hawliczek, R. (Vienna Univ. (Austria). Klinik fuer Strahlentherapie und Strahlenbiologie); Schmidt, W.; Neubauer, J. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48110 (INIS-mf–11515, pp. 51) **Digital two-dimensional scintillation dosimetry.** Leitner, H. (Graz Univ. (Austria). Radiologische Klinik); Stuecklschweiger, G.; Poier, E. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48111 (NAC–87-01) **Room clearance and radiation safety interlock system for neutron therapy treatment room.** Thomas, H.; Jones, D.T.L.; Hendrikse, W.L.J. Council for Scientific and Industrial Research, Faure (South Africa). National Accelerator Centre. Feb 1987. 26p. Available from the National Accelerator Centre, Council for Scientific and Industrial Research, PO Box 72, Faure, 7131, South Africa.

The NAC neutron therapy treatment room houses an isocentric gantry in which neutrons are produced by the reaction of 66 MeV protons on a beryllium target. A fail-safe room clearance and radiation safety interlock system has been designed to prevent accidental radiation exposure of personnel. The room clearance procedure has to be successfully completed before it is possible for the beam to be directed into the treatment room. Should the safety barriers be penetrated after the beam has been directed into the room, the beam will automatically be shut off. A full description of the features of the system and the procedures to be followed are described and all relevant electronic circuits are detailed. 10 figs.

48112 Stereotactic heavy-charged-particle Bragg peak radiosurgery for the treatment of intracranial arteriovenous malformations in childhood and adolescence. Levy, R.P. (Lawrence Berkeley Lab., CA (USA)); Fabrikant, J.I.; Frankel, K.A.; Phillips, M.H.; Lyman, J.T. *Neurosurgery (USA),* 24(6): 841-852 (Jun 1989).

Forty patients aged 6 to 18 years have now been treated for inoperable intracranial arteriovenous malformations (AVMs) using stereotactic heavy-charged-particle Bragg peak radiosurgery at the Lawrence Berkeley Laboratory 184-inch Synchrocyclotron at the University of California, Berkeley. This paper describes the procedures for selection of patients, the treatment protocol, and the neurological and neuroradiological responses to stereotactic radiosurgery in this age group. The volumes of the treated AVMs ranged from 265 mm^3 to 60,000 mm^3. The results are favorable: thus far, 20 of 25 patients have experienced greater than or equal to 50% obliteration of their AVMs within 1 year after treatment, and 14 of 18 patients have experienced total obliteration of the AVM by 2 years after treatment. Two patients hemorrhaged from radiosurgically treated AVMs within 12 months after treatment, but none thereafter. Complications include vasogenic edema and arterial occlusion; three patients have had neurological worsening as definite or possible sequelae of treatment. The strengths and limitations of the method are discussed.

5507 Microbiology

Refer also to citation(s) 46797, 46798, 46800, 46801, 46802, 46803, 46804, 46805, 46806, 46807, 46808, 46809, 46810, 46811, 46812, 46813, 46839, 46891

5509 Pathology

Refer also to citation(s) 48045, 48145, 48151, 48152

48113 (AD-A–207708/9/XAB) **Epidemiologic investigation of health effects in Air Force personnel following exposure to herbicides. Summary mortality update, 1989. Interim report 1979-1987.** Wolfe, W.H.; Michalek, J.E.; Miner, J.C. Science Applications International Corp., McLean, VA (USA). 17 Apr 1989. 35p. (USAFSAM-TR–89-9). Available from NTIS, PC A03/MF A01.

The purpose of the Air Force Health Study is to determine whether those individuals involved in the spraying of herbicides in Vietnam during the Ranch Hand operation have experienced any adverse health effects as a result of their participation in that program. The study is designed to evaluate both the mortality (death) and morbidity (disease) in these individuals over a 20-year beginning in 1982. The Baseline Mortality Report was released in June 1983, the Baseline Morbidity Report in February 1984. Follow-up mortality reports were released in 1984, 1985, and 1986. This study has not demonstrated health effects which can be conclusively attributed to herbicide or dioxin exposure. This report contains analyses of cumulative deaths occurring up to 31 December 1987. The overall cumulative mortality of the Ranch Hands remains statistically indistinguishable from that of both their matched Comparisons and the entire Comparison, population, although there is a statistically significant increasing trend in post-1983 death rates among Ranch Hand flying officers and a statistically significant increase in Ranch

Hand digestive system deaths relative to the Comparison population; these findings are not suggestive of a herbicide effect. Ranch Hands are equivalent to all Comparisons in cumulative accidental, malignant neoplasm and circulatory system mortality.

48114 (PB–89-155766/XAB) **TOXLEARN: Microcomputer-based training for TOXLINE. Software.** Perkins, M. National Library of Medicine, Bethesda, MD (USA). Specialized Information Services. 1989. vp. Available from NTISCP D99.

The software is contained on 3 1/2 and 5 1/4-inch diskettes, double density (360K) and (720K), compatible with the IBM PC/XT/AT/PS2 microcomputer. The diskettes are in the ASCII format.

TOXLEARN is a microcomputer-based training package for TOXLINE. It is designed to teach librarians and information specialists, as well as scientists, how to search TOXLINE effectively. Its menu-driven structure makes it easy for new users to learn the basics of search for TOXLINE. In addition, TOXLEARN provides the skilled searcher with a way to easily reinforce or recall previously-learned search techniques. TOXLEARN contains approximately four hours of interactive instruction. Software Description: The software was developed under PILOTplus using the NLM LEARN Programmer. It runs on IBM-PC, XT, AT, PS2 and fully compatible computers. It requires 512K RAM memory, one disk drive, and DOS 2.0 or higher. It supports most monochrome, color graphics, enhanced color graphics, or visual graphics displays.

48115 (PB–89-199004/XAB) **Toxic Release Inventory (TRI), United States and Territories, 1987 (DBASE III) (for microcomputers). Data file.** Zaiss, F.; Nowak, G. Environmental Protection Agency, Washington, DC (USA). Office of Toxic Substances. 1987. vp. Available from NTISsee individual diskette for order number and price.

Set includes PB89-199012 through PB–89-199533 TRIs for each state and territory; The data file is contained on 5 1/4 inch diskettes, high density (1.2M), compatible with the IBM PC/AT microcomputer. The diskettes are in the dBASE III format. Price includes documentation, PB–89-186076.

Section 313 of the Emergency Planning and Community Right-to-Know Act (also known as Title III) of the Superfund Amendments and Reauthorization Act of 1986 (Public Law 99-499) requires EPA to establish an inventory of routine toxic chemical emissions from certain facilities. The list of toxic chemicals subject to reporting consisted initially of chemicals listed for similar reporting purposes by the States of New Jersey and Maryland. There are over 300 chemicals and categories on these lists. The reporting requirement applies to owners and operators of facilities that have 10 or more full-time employees, that are in Standard Industrial Classification (SIC) codes 20 through 39 (i.e., manufacturing facilities) and that manufacture (including importing), process or otherwise use a listed toxic chemical in excess of specified threshold quantities. Individual documents for each state or territory are available in the set.

48116 (PB–89-199541/XAB) **Toxic Release Inventory (TRI), United States and territories, 1987 (Lotus 1-2-3) (for microcomputers). Data file.** Zaiss, F.; Nowak, G. Environmental Protection Agency, Washington, DC (USA). Office of Toxic Substances. 1987. vp. Available from NTISsee individual diskette for order number and price.

Set includes PB–89-199558 through PB–89-200075, TRIs for each state and territory; The data file is contained on 5 1/4-inch diskettes, high density (1.2M), compatible with the IBM PC/AT microcomputer. Diskettes are in the LOTUS 1-2-3 format. Price includes documentation, PB–89-186076.

Section 313 of the Emergency Planning and Community Right-to-Know Act (also known as Title III) of the Superfund Amendments and Reauthorization Act of 1986 (Public Law 99-499) requires EPA to establish an inventory of routine toxic chemical emissions from certain facilities. The list of toxic chemicals subject to reporting consisted initially of chemicals listed for similar reporting purposes by the States of New Jersey and Maryland. There are over 300 chemicals and categories on these lists. The reporting requirement applies to owners and operators of facilties that have 10 or more full-time employees, that are in Standard Industrial Classification (SIC) codes 20 through 39 (i.e., manufacturing facilities) and that manufacture (including importing), process or otherwise use a listed toxic chemical in excess of specified threshold quantities. Individual documents for each state or territory are available in the set.

5520 Public Health

Refer also to citation(s) 46887, 47230, 47939, 47942, 47944, 47956, 48155

48117 (ORNL/FTR–3192) **[Uncertainties of environment models in public health and environmental protection]: Foreign trip report, March 3–10, 1989.** Gardner, R.H. Oak Ridge National Lab., TN (USA). 20 Mar 1989. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017354/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report describes the foreign travel of Robert H. Gardner who attended a workshop, "Uncertainty and Sensitivity Analysis," organized by Rijksinstitute voor Volksgezondheid en Milieuhygine [the National Institute of Public Health and Environmental Protection (RIVM)] at RIVM headquarters in Bilthoven, The Netherlands. R. H. Gardner was invited by RIVM to present a series of lectures concerning the past work by ESD personnel on the theory and methods of assessing the uncertainties associated with environmental models. R. H. Gardner was also invited to visit a nearby institute, Rijksinstituut voor Natuurbeheer [Research Institute for Nature Management (RIN)] and discuss new developments of theoretical methods in landscape ecology with Paul Opdam and his staff. Environmental problems at local, regional, and global scales are receiving a great deal of attention by the public, press, and politicians in The Netherlands because of recent publications by RIVM. The workshop attempted to address the important issues of estimating the uncertainties of the model that RIVM uses to make their assessments. The speakers for the workshop represented a diverse array of specialists in the field of model development and analysis.

5530 Agriculture and Food Technology

Refer also to citation(s) 48128, 48155

56 BIOMEDICAL SCIENCES, APPLIED STUDIES

5601 Radiation Effects

Refer also to citation(s) 47125, 47128, 47129, 47155, 47156, 47158, 47837, 47842, 47959

48118 (AD-A–205811/3/XAB) **Antioxidant mechanisms in radiation injury and radioprotection.** Weiss, J.F.; Kumar, K.S. Armed Forces Radiobiology Research Inst., Bethesda, MD (USA). 1988. 28p. (AFRRI-SR–88-47). Available from NTIS, PC A03/MF A01.

Pub. in Cellular Antioxidant Defense Mechanisms, Vol. 2, 163-189(1988).

Oxygen is a very important factor in determining radiosensitivity because it enhances the damage to cellular components caused by ionizing radiation, although mechanisms involved in UV irradiation damage may overlap ionizing radiation effects. This paper emphasizes chemical protection against damage by ionizing radiation and predominantly against the effects of photons (and gamma radiation). It is possible that free radicals and their products induced by ionizing radiation can interact with reactive oxygen species formed during normal processes, such as superoxide and hydrogen peroxide produced by phagocytic cells or during enzymatic processes (xanthine oxidase activity; enzymes involved in eicosanoid metabolism). Metals such as iron can promote free radical damage, whereas some bound metals have radioprotectant potential, e.g., metallothionein and ceruloplasmin. There is increasing evidence that maintenance of the proper oxidation-reduction state of cells by the interconversion of the peptide sulfhydryl glutathione (GSH), and its disulfide form (GSSG) is a factor in the modulation of cellular radiosensitivity. Other protein and nonprotein sulfhydryls may also play a role both as targets of radiation damage and as protectors.

Other physiological antioxidants (vitamin E) and antioxidant enzymes are interrelated in their function of controlling oxidative processes. This review concentrates on the role of oxygen, glutathione, and antioxidant enzymes in radiosensitivity and how exogenous chemicals interact with these endogenous factors.

48119 (AD-A-207917/6/XAB) **Thermospray liquid-chromatography mass spectrometry of thiol radioprotective agents: Characteristics spectra. Scientific report.** Walden, T.L.; Buchner, J.; Pizzitola, V.; Blakeley, W.F. Armed Forces Radiobiology Research Inst., Bethesda, MD (USA). 1988. 4p. (AFRRI-SR-89-13). Available from NTIS, PC A02/MF A01.

Pub. in Pharmacology and Therapeutics, Vol. 39, 219-221(1988).

Ethiofos (S-2(3-aminopropylamino)ethylphosphorothioic acid or WR-2721) is currently being evaluated in clinical radiotherapy trials (Kligerman et al., 1980) because of its potential for enhancing the efficacy of radiotherapy (Kligerman et al., 1980; Yuhas and Storer, 1969). For proper drug usage and pharmacological studies, it is necessary to assess the stability of the aminothiol and the presence of impurities or decomposition products. In addition, monitoring the plasma levels of WR-2721 and its metabolites should improve the therapeutic usefulness of WR-2721. Several high-performance liquid chromatography (HPLC) methodologies have been developed that are applicable for routine analysis of aminothiols and endogeneous cellular thiols (Newton et al., 1981; Swynnerton et al., 1984). One of these methodologies, electrochemical detection, permits the simultaneous detection of the free thiol and the disulfides (Swynnerton et al. 1984). Mass spectrometry (MS) is a sensitive technique that can confirm purity and provide useful structural information. Using a thermospray interface, samples can be introduced into the mass spectrometer from a liquid chromatograph (LC) (Vestal, 1984). The interface thermally nebulizes the eluant into a high-pressure region of the mass spectrometer where a variety of soft-ionization techniques may be used to ionize the analyte molecules. The feasibility of LC coupled to MS-detection was studied for the analysis of thiol-containing radioprotective agents, including glutathione, WR-2721, and WR-1065, the dephosphorylated sulfhydryl form of WR-2721, which has been shown to be its active radioprotective metabolite (Calabro-Jones et al., 1983).

48120 (AERE-M-3618(rev.)) **Electron spin resonance studies of radiation effects in biological materials. An assessment of current and future research.** Dalgarno, B.G. UKAEA Harwell Lab. (UK). Environmental and Medical Science Div. Jun 1987. 5p. Available from H.M. Stationery Office, London, price Pound 5.00.

Electron spin resonance spectroscopy can provide a powerful approach to the study of radiation effects in biological materials. This memorandum gives an overview of current and future research. (author).

48121 (CONF-881190-4) **RBE [relative biological effectiveness] of tritium beta radiation to gamma radiation and x-rays analyzed by both molecular and genetic methods.** Lee, W.R. Louisiana State Univ., Baton Rouge, LA (USA). Dept. of Zoology and Physiology. 1988. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-86ER60393. From 3. Japan-US workshop on tritium radiobiology and health physics; Kyoto (Japan); 8-10 Nov 1988. Order Number DE89015373/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The relative biological effectiveness (RBE) of tritium beta radiation to ^{60}Co gamma radiation was determined using sex-linked recessive lethals (SLRL) induced in Drosophila melanogaster spermatozoa as the biological effect. The SLRL test, a measure of mutations induced in germ cells transmitted through successive generations, yields a linear dose-response curve in the range used in these experiments. From these ratios of the slopes of the ^{3}H beta and the ^{60} Co gamma radiation linear dose response curves, an RBE of 2.7 is observed. When sources of error are considered, this observation suggests that the tritium beta particle is 2.7 $\pm$ 0.3 times more effective per unit of energy absorbed in inducing gene mutations transmitted to successive generation than ^{60}Co gamma radiation. Ion tracks with a high density of ions (high LET) are more efficient than tracks with a low ion density (low LET) in inducing transmissible mutations, suggesting interaction among products of ionization. Molecular analysis of x-ray induced mutations shows that most mutations are deletions ranging from a few base pairs as determined from sequence data to multi locus deletions as determined from complementation tests and Southern blots. 14 refs., 1 fig.

48122 (DLG-538030) **Radiocesium binding substances in livestock production.** Giese, W.; Rudnicki, S. Deutsche Landwirtschafts-Gesellschaft e.V., Frankfurt am Main (Germany, F.R.). 1988. 43p. (In German). Order Number DE90702760/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

Three groups of fattening pigs were given radiocesium-contaminated mixed feeds over a period of twelve weeks. Two of these groups received ammonium-iron hexacyanoferrate in quantities of 0.5 or 1.0 g /kg of mixed feeds, admixed to the feeds. Analyses of muscle and organ specimens by means of gamma spectrometry revealed a highly reduced radiocesium activity in the two croups that received the salt admixtures, as compared to the control group. The analyses did not indicate a depletion of sodium or potassium due to the Giese salt admixtures. (orig.).

48123 (EUR-11608, pp. 81-96) **Medical view of the health effects of the pre-Chernobyl nuclear incidents and accidents.** Proukakis, C. (Athens Univ. (GR). Dept. of Physics). Commission of the European Communities, Luxembourg (Luxembourg). 1988. (CONF-8710489-: 1. meeting of the standing conference on health and safety in the nuclear age, Luxembourg (Luxembourg), 5-7 Oct 1987). In *Health and safety in the nuclear age.* Available from NTIS (US Sales Only), PC A12/MF A01.

The stochastic effects of radiation in man and the non-stochastic effects of some important or characteristic nuclear accidents that have taken place up to April 1986, are described. The stochastic effects can be estimated from the collective dose that is from the number of exposed people and the dose to each one of them, according to the health hazards, as estimated by the International Commission for Radiological Protection and other international Organizations. A nuclear accident might be severe from a medical point of view even if the effects of radiation to the health are not expected to be significant. Serious mental stress might be induced to the general public and this is more likely to happen if the competent authorities do not take any action, or sometimes if they enforce unnecessary countermeasures. The pre-Chernobyl important nuclear accidents which affected large numbers of the general public are the Windscale and the Three Mile Island accidents. They are briefly described.

48124 (EUR-11608, pp. 97-126) **Radiological impact of the Chernobyl reactor accident, on the countries of the European Community.** Webb, G.A.M. (National Radiological Protection Board, Chilton (GB)). Commission of the European Communities, Luxembourg (Luxembourg). 1988. (CONF-8710489-: 1. meeting of the standing conference on health and safety in the nuclear age, Luxembourg (Luxembourg), 5-7 Oct 1987). In *Health and safety in the nuclear age.* Order Number DE89908200/JAW. Available from NTIS (US Sales Only), PC A12/MF A01.

The accident at the Chernobyl Unit 4 reactor in the USSR, in April 1986, resulted in large quantities of radioactive materials being released into the atmosphere over a period of several days. During this time a complex set of meteorological conditions occurred which dispersed and deposited these materials over large areas of Europe. Levels of radioactivity in the environment were monitored by national authorities, and in some countries countermeasures were introduced in order to reduce the radiation exposure of individuals in the population. Several papers have already been published in the scientific literature reporting environmental measurements made by various institutions and assessing the implications of these measurements in terms of predicted radiation doses to exposed individuals. These studies have tended to be for specific countries and are, by their very nature, only first estimates. The aim of the study described in this paper is to review the environmental contamination measured in Member States of the European Community (EC); to make a preliminary assessment of individual and population doses for each country; to make an estimate of the resulting health impact and to indicate the effects of the various preventive measures instigated by Member States in terms of the reductions in both individual and population exposure which they produced.

48125 (INIS-mf–11515, pp. 49) **Troubles of cardiac pacemakers due to irradiation at a linear accelerator.** Poier, E. (Graz Univ. (Austria). Radiologische Klinik); Stuecklschweiger, G.; Leitner, H.; Arian-Schad, K.; Agnelli-Monti, M. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48126 (INIS-mf–11515, pp. 54) **Effect of high radiation doses on human fetuses.** Kallinger, W. (Krankenhaus der Stadt Wien-Lainz (Austria). Pruefanstalt fuer Radiologie); Graninger, W. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48127 (INIS-mf–11515, pp. 57) **Long-term investigation of the time dependence of radioactive cesium concentrations in human muscle tissue.** Rabitsch, H. (Technische Univ., Graz (Austria). Inst. fuer Theoretische Physik und Reaktorphysik); Feenstra, O.; Kahr, G. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48128 (INIS-mf–11529) **Influence of storage on fungal infestation in spices.** Akhtar, T.; Sattar, A.; Khan, I. Nuclear Inst. for Food and Agriculture, Peshawar (Pakistan). Jan 1988. 3p. Order Number DE90601325/JAW. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS.

NIFA annual report 1987-88.

The present work was carried out to study the influence of storage and gamma radiation on fungal control in spices. The spices were irradiated with 5.0, 7.5 and 10.0 KGy and stored under ambient conditions for 12 months. Fungal infestation decreased to undetectable levels upon irradiation of these spices especially at higher doses and increased with advanced storage period both the irradiated and unirradiated samples. (orig. /A.B.).

48129 (KFK–4592) **Risk of plutonium: Estimate and control. Biological background and organizational-technical measures.** Volf, V. Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Inst. fuer Genetik und Toxikologie von Spaltstoffen. May 1989. 132p. (In German). Order Number DE90702851/JAW. Available from NTIS (US Sales Only), PC A07/MF A01.

The risk of plutonium for man is compared with radiation risks due to other fission products as well as natural radiation sources. Furthermore, the principles of controlling the risks of plutonium by a system of radiation protection standards and corresponding technical and medical measures are described. The report is based to a great extent on publications prepared by international scientific commissions. (orig.).

48130 (NCRP–101) **Exposure of the US population from occupational radiation.** National Council on Radiation Protection and Measurements, Bethesda, MD (USA). c 1 Jun 1989. 106p. Sponsored by National Council on Radiation Protection and Measurements. Available from National Council on Radiation Protection and Measurement Publications, 7910 Woodmont Ave., Suite 800, Bethesda, MD 20814 $15.00.

The National Council on Radiation Protection and Measurements (NCRP) has reviewed the literature on the subject of occupational exposure to ionizing radiation to assemble, in a single document, the effective dose equivalents and the collective effective dose equivalents for the work force. Although achieving this goal involved the difficulties, the current Report provides evidence that occupational exposures are responsible for only a small fraction of the total collective effective dose equivalent for the entire US population. The current Report is intended primarily for the information of the radiation protection community, but it should also be of interest to the layperson for the perspective it provides on the contribution of occupational exposures to the total population exposure.

48131 (ORNL/FTR–2939) **[Participation in the Genetic Sub-subgroup at the United Nations Scientific Committee on the Effects of Atomic Radiation]: Foreign trip report, June 13–17, 1988.** Selby, P.B. Oak Ridge National Lab., TN (USA). 27 Jun 1988. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017435/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler attended the thirty-seventh session of UNSCEAR where he took an active part in the deliberations of the Genetic Sub-subgroup. When that group was not in session, he either took part in sessions of the Biology Subgroup or observed sessions of the main UNSCEAR committee. The traveler was responsible for making substantive changes in the two documents dealing with genetics that were completed at this meeting. Both reports will be published later this year. Important contacts were made with several prominent geneticists. It was apparent how important it is to ORNL, to DOE, to the United States Government, and to UNSCEAR itself to have a representative from the United States present who has firsthand familiarity with the mouse data that are used to such an important extent in genetic risk estimation. Many of these data were collected in the Biology Division of ORNL.

48132 (ORNL/FTR–2977) **[Workshop on radiation research related to space stations and missions beyond the magnetosphere]: Foreign trip report, July 17–24, 1988.** Fry, R.J.M. Oak Ridge National Lab., TN (USA). 2 Aug 1988. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017413/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler's objectives were (1) to give the the introduction and chair the third session of the Workshop on Radiation Research Related to Space Stations and Missions Beyond the Magnetosphere, which Prof. Buecker, Dr. D. S. Nachtwey and the traveler had organized; (2) to act as referee for the papers presented in Session 2 of the Symposium on the impact of environmental factors on radiobiological processes in space; (3) to attend the meeting of the chairmen and vice chairmen of the Commissions as vice chairman of the Commission of Life Sciences; and (4) to attend the editorial meeting of Advances in Space Research. One of the papers presented was co-authored by the traveler.

48133 (ORNL/FTR–3065) **[Low dose radiation biological bases of risk assessment]: Foreign trip report, September 2-21, 1988.** Fry, R.J.M. Oak Ridge National Lab., TN (USA). 3 Oct 1988. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017433/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler's objective was (1) to attend the ICRP Committee I Meeting and present a draft report from the Task Group on the Biological Basis for Dose Limitation in the Skin; (2) to present an invited paper at the 14th L.H. Gray Conference; Low Dose Radiation Biological Bases of Risk Assessment; and (3) to chair the meeting of ICRP's Task Group on the Biological Basis for Dose Limitation in the Skin.

48134 (ORNL/FTR–3144) **[Training workshop on radiological dose assessment]: Foreign trip report, December 3–8, 1988.** Blaylock, B.G. Oak Ridge National Lab., TN (USA). 19 Dec 1988. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017367/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The International Atomic Energy Agency (IAEA) and the US Department of Energy sponsored a training workshop in Cairo, Egypt, on radiological dose assessment for the Nuclear Regulatory and Safety Center of the Atomic Energy Authority of Egypt. Dr. Herman Cember from Northwestern University, Dr. John Rundo from Argonne National Laboratory, and the traveler were requested to teach the course. The course included quantitative internal and external radiation dosimetry, atmospheric and aquatic transport of radionuclides in the environment, foodchain pathways, and bioassays analysis. Approximately thirty individuals with an average

educational level equivalent to an M.S. degree attended the course. The educational background of most students was in physics and health physics; however, there was considerable interest in radiological risk assessment related to the disposal of radioactive waste.

48135 (ORNL/FTR–3256) **[Dose and dose-rate effects on radiation response]: Foreign trip report, May 5–13, 1989.** Selby, P.B. Oak Ridge National Lab., TN (USA). 25 May 1989. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017450/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler attended the thirty-eighth session of UNSCEAR where he took part in the meetings of the Biological Subgroup and the Working Group of the entire UNSCEAR Committee. He was responsible for the correction of several major errors in the draft version of the document entitled "Dose and Dose-Rate Effects on Radiation Response. " He also played a key role in bringing about UNSCEAR's decision to prepare a document on hereditary defects in the current cycle. To a large extent, it was because of the traveler's arguments that UNSCEAR reversed the Secretariat's decision not to reevaluate genetic risk in this cycle and decided that a genetics report was among its highest priorities. Important contacts were made with many internationally prominent scientists involved in radiation protection and risk evaluation. It was apparent how important it is to ORNL, to DOE, to the United States Government, and to UNSCEAR itself to have a representative from the United States present who has firsthand familiarity with the mouse data that are used to such an important extent in genetic risk estimation. Many of these data were collected in the Biology Division of ORNL.

48136 (PB–89-187272/XAB) **Collaborative Radiological Health Laboratory annual report 1987: health effects of prenatal and postnatal whole-body exposure to ionizing radiation in the beagle dog. Annual report.** Colorado State Univ., Fort Collins, CO (USA). Collaborative Radiological Health Lab. Sep 1988. 73p. Available from NTIS, PC A04/MF A01.

See also PB–88-142724.

The Collaborative Radiological Health Laboratory (CRHL) was established in 1962 by the U.S. Public Health Service and Colorado State University for the purpose of determining in a carefully controlled animal experiment the lifetime hazards associated with prenatal and early postnatal exposure to ionizing radiation. The CRHL study is designed to provide information that will facilitate the evaluation of risks to human beings from medical exposure during early development. It is a long-term (life span) study of a moderately large and long-lived mammal exposed at one of several times during development to a relatively small and discrete dose of external radiation. Ages-at-irradiation selected for comparison reflect the primary concern with medical exposures during the developmental period. The basic experiment under the contract contains 1,680 beagles that will be maintained and evaluated for most of their natural lives. The annual report summarizes the current status of the study for the reporting period of November 21, 1986 through November 20, 1987.

48137 (SSA–1988-TS-9, pp. 41-42) **Influence of pyridostigmine on the antiemetic effect of domperidone in irradiated macaques.** Roman, V. (Centre de Recherches du Service de Sante des Armees, 38 - La Tronche-Grenoble (FR)); Court, L.; Fatome, M. Centre de Recherches du Service de Sante des Armees, 92 - Clamart (France). 1988. (In French). In *Scientific works 1987. Centre de Recherches du Service de Sante des Armees.* Order Number DE89764017/JAW. Available from NTIS (US Sales Only), PC A14/MF A01.

Macaques have received 75 minutes before a neutron-gamma irradiation at 5 Gy (n/y = 5.5) an I.M. injection of Domperidone at 2 mg per animal and an I.V. injection of Pyridostigmine at 0.2 mg. kg^{-1}, others have received the Domperidone at the same dose and physiologic serum, in a double-blind experiment. The association of the compounds has not shown any particular toxicity and has led to a strengthening of the antiemetic action.

48138 (SSA–1988-TS-9, pp. 39-40) **Influence of the association pyridostigmine-gamma irradiation (15 Gy) on the physical performances of the macacus cynomolgus.** Mestries, J.C. (Centre de Recherches du Service de Sante des Armees, 38 - La Tronche-Grenoble (FR)); Lechevin, J.M.; Picard, G.; Fatome, M.; Court, L. Centre de Recherches du Service de Sante des Armees, 92 - Clamart (France). 1988. (In French). In *Scientific works 1987. Centre de Recherches du Service de Sante des Armees.* Order Number DE89764017/JAW. Available from NTIS (US Sales Only), PC A14/MF A01.

In overtrained Cynomolgus monkey which was submitted to an exertion test after an intra-muscular injection of Pyridostigmine at 0.1 mg.kg^{-1} immediately before a gamma global irradiation at 15 Gy, it was observed an important decreasing of performances and a disappearance of the benefic effect of overtraining. A total restoration was observed between the second and the forth days.

48139 Relationship between kidney burden and radiation dose from chronic ingestion of U: implications for radiation standards for the public. Kocher, D.C. (Oak Ridge National Lab., TN (USA)). *Health Physics (USA),* 57(1): 9-15 (Jul 1989).

Metabolic models for U in adults recommended by Wrenn et al. (1985) and the International Commission on Radiological Protection (ICRP 1979a) were used to study the relationship between kidney burden and radiation dose from chronic ingestion of soluble 238U or natural U and whether current radiation standards for the public provide adequate protection against chemical toxicity from U in the kidney. We assumed that the threshold concentration for chemical toxicity is 1 microgram of U g-1 of kidney and that a safety factor of 10 should be applied in limiting kidney burdens for maximally exposed individuals in the general public. We found that a limit on annual effective dose equivalent of 1 mSv (0.1 rem) for chronic exposures of the public from all sources, as recommended by the ICRP (1985) and the National Council on Radiation Protection and Measurements (NCRP 1987), corresponds to concentrations of U in the kidney from chronic ingestion that exceed the assumed threshold for chemical toxicity of 1 microgram g-1 only for 238U using the metabolic model of the ICRP (1979a). However, using either metabolic model (ICRP 1979a; Wrenn et al. 1985), the predicted concentrations of U in the kidney exceeded the limit of 0.1 microgram g-1, based on the assumed safety factor for protection of the public, for both 238U and natural U. From these results, we concluded that chemical toxicity should be considered in developing health protection standards for the public for ingestion of soluble 238U or natural U. Environmental radiation standards for certain practices established by the U.S. Environmental Protection Agency and Nuclear Regulatory Commission (EPA 1987a, 1987b, 1987c, 1987d; NRC 1988a) are consistent with a limit on annual effective dose equivalent of 0.25 mSv (25 mrem) per practice. If the metabolic model of Wrenn et al. 27 references.

48140 The half-life of ^{218}Po. Martz, D.E. (Department of Energy, Grand Junction Projects Office, CO (USA)); Harris, R.T.; Langner, G.H. Jr. *Health Physics (USA),* 57(1): 121-130 (Jul 1989).

Direct observation of the ^{218}Po alpha-peak decay with a microcomputer-controlled alpha-spectrometer yielded a mean half-life value of 3.040 +/- 0.008 min, where the error quoted represents twice the standard deviation of the means from 38 separate decay measurements. The 1912 and 1924 ^{218}Po half-life measurements, which provided the 3.05-min value listed in nuclear tables for the past 60 y, are critically reviewed. Two more recent experiments, which yielded longer values of 3.11 min and 3.093 min, are also discussed. 25 references.

5602 Thermal Effects

Refer also to citation(s) 48047

5603 Chemicals Metabolism and Toxicology

Refer also to citation(s) 47945, 48036, 48074, 48113

48141 (DFVLR-FB–89-16) **Investigation on analysing computer-aided forest disease classifications.** Kuntz, S. Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt e.V., Koeln (Germany, F.R.); Freiburg Univ. (Germany, F.R.). Forstwissenschaftliche Fakultaet. 1989. 162p. (In German). Order Number DE90702748/JAW. Available from NTIS (US Sales Only), PC A08/MF A01.

Computer-aided forest disease classifications based on multispectral airborne scanner data were presented during the last years from different authors. Essential problems occurred by trying to check the results. Within this work airborne scanner data from different altitudes were investigated. After the computer-aided classifications methodologies for statistical checking the results were developed and tested over damaged forest areas. Simultaneously the quality of the classification could be improved when digital terrain information was involved. (orig.) With 29 figs., 19 tabs., 225 refs.

48142 (KFK-PEF–49) **Open-top chamber experiments for investigating the effect of pollutants on growth and health of forest (feasibility study).** Kenk, G.; Boehm, G.; Hungar, U. Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.). Projekt Europaeisches Forschungszentrum fuer Massnahmen zur Luftre. Nov 1988. 76p. (In German). Contract PEF 85/003/1A. Order Number DE90702738/JAW. Available from NTIS (US Sales Only), PC A05/MF A01.

Reported are the results of a test period with special open top chambers. Construction was more stable and dimension bigger as usual because of planned experimental design with higher forest plants on an elevated site of the Black Forest. The test for two years proved nearly trouble-free chamber technics. But crucial problems were caused by the climate of the chambers: Compared with outside, air temperatures are seriously elevated (greenhouse effect) and humidity is levelled down. Solar insolation was diminished by the chambers framework and altered by foil induced selective filtration of photosynthetic important wave-lengths of light. There was no dew or fog within the chambers. Temperatures in the soil were changed distinctly. The chambers climatic effects on physiology of test plants were evaluated to be very seriously and not to accept. Therefore, the project has not been continued, but finished. (orig./MG) With 5 figs., 14 tabs., 45 refs.

48143 (ORNL–6451) **Treatability of hazardous chemicals in soils: Volatile and semivolatile organics.** Walton, B.T.; Hendricks, M.S.; Anderson, T.A.; Talmage, S.S. Oak Ridge National Lab., TN (USA). Jul 1989. 285p. Sponsored by Environmental Protecction Agency. DOE Contract AC05-84OR21400. DW 89931473-01-0. Order Number DE89016892/JAW. Available from NTIS, PC A13/MF A01 - OSTI; GPO Dep.

Selected hazardous organics, primarily volatiles and semivolatiles, were evaluated for toxicity to soil microorganisms, sorption to soil, degradation, and potential for bioaccumulation in terrestrial plants and animals. In addition, a structure-activity approach was used for data analysis, because this technique may prove useful to predict rate constants for critical environmental processes in soils as well as to provide criteria to prescreen hazardous organic contaminants for ecotoxicological potential. These capabilities are needed for mathematical modeling of chemical fate in the terrestrial environment and for conducting environmental risk assessments. The chemicals included in the study were acrylonitrile, furan, methyl ethyl ketone, tetrahydrofuran, benzene, toluene, 1,2-dichloroethane, p-xylene, chlorobenzene, chloroform, nitrobenzene, trans-1,4-dichloro-2-butene, cis-1,4-dichloro-2-butene, 1,2-dichlorobenzene, 1,2,3-trichloropropane, carbon tetrachloride, 2-chloronaphthalene, benzidine, ethylene dibromide, 3,3'-dimethylbenzidine, 1,2,4,5-tetrachlorobenzene, 3,3'-dichlorobenzidine, methapyrilene, and hexachlorobenzene. 49 refs., 9 figs., 21 tabs.

48144 (ORNL/FTR–3023) **[Air Force asbestos management program]: Foreign trip report, August 16–September 3, 1988.** Davis, K.M. Oak Ridge National Lab., TN (USA). 15 Sep 1988. 15p. Sponsored by DOD;DOE/DP. DOE Contract AC05-84OR21400. Order Number DE89017407/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Kenneth Davis, with Mr. Donald Main and Mr. Robert White of URS Corporation, visited Yokota Air Force Base, Tokyo, Japan, August 23 through August 31, 1988. The purpose of the trip was to directly involve all pertinent Base organizations in the development of an Asbestos Management Operations Plan for the Base. A series of meetings and briefings were held with all organizations on the Base that would have any input to an asbestos management program, to determine their current role as well as discuss any future role under the new Plan.

48145 (ORNL/FTR–3189) **[Short-term assays for detecting environmental mutagens, carcinogens, and teratogens]: Foreign trip report, February 4–28, 1989.** Generoso, W.M. Oak Ridge National Lab., TN (USA). 8 Mar 1989. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017431/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler participated in the Second Southeast Asian Workshop on Short-term Assays for Detecting Environmental Mutagens, Carcinogens, and Teratogens, held in Bangkok and Chiang Mai, Thailand. He was a member of the International Advisory Committee of this Workshop, was a coordinator of the US delegation, and delivered two lectures. While in Bangkok, he participated in two round-table discussions on subjects of immediate significance to Thailand. He also traveled to The Philippines where he gave a lecture at the University of the Philippines in Quezon City. The contacts made by the traveler resulted in a US Environmental Protection Agency-initiated discussion of future funding for in vivo aneuploidy research at ORNL.

48146 (PB–89-181416/XAB) **Effects of acid and aluminum on swim bladder development and yolk absorption in the fathead minnow, pimephales promelas, (journal version).** Leino, R.L.; McCormick, J.H.; Jensen, K.M. Environmental Protection Agency, Duluth, MN (USA). Environmental Research Lab. May 1988. 8p. (EPA–600/D-89/077). Available from NTIS, PC A02/MF A01.

Pub. in Canadian Technical Report of Fisheries and Aquatic Sciences, Vol. 1607, 37-41(May 1988).

Thirty-day old fathead minnows were raised to maturity and spawning in a laboratory flow-through system using softened water at various pH and Al levels. Successful spawnings were reduced by more than 85% at pH 6.0, 5.5-25 microg/L Al+3, and 5.5, and absent in all pH 5.2 treatments. Hatching success, larval survival, swim bladder development and yolk absorption were reduced or abnormal when spawning did occur at lower pHs.

48147 (PB–89-181770/XAB) **Roles of pH, titratable acid, and specific chemical composition in mediating effects of acid aerosols on the airways. Final report.** Sheppard, D.; Gordon, T.; Fine, J.M. California Univ., San Francisco, CA (USA). Lung Biology Center. Jul 1986. 50p. Available from NTIS, PC A03/MF A01.

The investigators exposed asthmatic subjects to aerosols of sulfuric and hydrochloric acid to study the relative importance of different factors on the bronchoconstrictor potency of acid aerosols. The investigators also compared the bronchoconstrictor potency of sulfite aerosols inhaled at 3 different pHs to examine the relative importance of the two different ionic forms of sulfite and of the sulfur dioxide gas with which these ions are in equilibrium. Finally, to determine if other measurements would be more-sensitive indicators of the effects of acid aerosols than bronchoconstriction, they examined the effects of exposure to acid aerosols on guinea pigs.

48148 (PB–89-187934/XAB) **Carcinogenicity of azo dyes: Acid Black 52 and Yellow 3 in hamsters and rats. Volume 2. Technical report (Final).** Plankenhorn, L.J. Borriston Labs., Inc., Temple Hills, MD (USA). 30 Sep 1983. 169p. Available from NTIS, PC A08/MF A01.

See also PB–84-201136.

This document is an appendix to a study concerning the carcinogenicity of the azo dyes acid-black-52 and yellow-3 in male and female hamsters and rats and contains individual histopathology studies of both dyes. Histopathological features were reported in tabular form for the skin, mammary gland, muscle, salivary gland, mandibular lymph node, sciatic nerve, thymus, larynx, thyroid, parathyroid, trachea, bronchus, esophagus, adrenal, stomach, duodenum, jejunem, ileum, cecum, colon, rectum, mesenteric lymph node, lung, liver, gallbladder, spleen, pancreas, kidney, heart, urinary bladder, seminal vesicle, prostate, testis, cerebrum, cerebellum, pituitary, sternabrae, femur, bone marrow, and nasal cavity.

48149 (PB–89-187975/XAB) **Evaluation of research on cadmium inhalation-exposure estimate and their significance for kidney and liver cadmium burden.** Mahaffey, K.R. Robert A. Taft Labs., Cincinnati, OH (USA). Nov 1986. 12p. Available from NTIS, PC A03/MF A01.

The time-weighted exposure matrix for cadmium suggested in an earlier study was evaluated to identify factors in the association between occupational cadmium exposure and accumulation of tissue cadmium burden that requires additional consideration. The external dose of cadmium was undoubtedly underestimated because the ingestion route was not evaluated. Another potential complication was that age may be a factor in producing increased urinary excretion of proteins. A solution would be to calculate these data with age as a covariable. Another major consideration was the high person-to-person variability in the half time of cadmium in liver and kidney. Whether this reflected biological variation, time exposure, or anomalies in the exposure matrix could not be judged from the available data. Even so, assuming a biological basis, person-to-person variability was an important consideration in evaluating the relation between external exposure and renal damage. The author concludes that the approach taken in the earlier report appears to be the best method for associating occupational cadmium exposures with renal dysfunction.

48150 (PB–89-190391/XAB) **Health-risk assessment of trichlorofluoromethane in California drinking water.** Reed, N.R.; Reed, W.; Weir, K.; Beltran, K.; Babapour, R. California Univ., Davis, CA (USA). Dept. of Environmental Toxicology. 22 Dec 1988. 93p. (UCD/ET–88/4). Available from NTIS, PC A05/MF A01.

Existing literature is reviewed that is pertinent to the health risk posed by the use of Freon-11 contaminated drinking water, an estimation of the Freon-11 exposure for California residents based on the most recent data on Freon-11 concentrations in California drinking-water supplies, and a delineation of the level of Freon-11 that may cause a noncarcinogenic health effect.

48151 (PB–89-194468/XAB) **Toxicological profile for methylene chloride. Final report.** Life Systems, Inc., Cleveland, OH (USA). Apr 1989. 123p. Available from NTIS, PC A06/MF A01.

The Agency for Toxic Substances and Disease Registry Toxicological Profile for Methylene Chloride is intended to characterize the toxicological and health effects information for the substance. It identifies and reviews the key literature that describes the substance's toxicological properties. The profile begins with a public health statement, which describes in nontechnical language the substance's relevant toxicological properties. Following the statement is material that presents levels of significant human exposure and, where known, significant health effects. The adequacy of information to determine the substance's health effects is described. The focus of the document is on health and toxicological information.

48152 (PB–89-194476/XAB) **Toxicological profile for cadmium. Final report.** Life Systems, Inc., Cleveland, OH (USA). Mar 1989. 116p. Available from NTIS, PC A06/MF A01.

The Agency for Toxic Substances and Disease Registry Toxicological Profile for Cadmium is intended to characterize the toxicological and health effects information for the substance. It identifies and reviews the key literature that describes the substance's toxicological properties. The profile begins with a public health statement, which describes in nontechnical language the substance's relevant toxicological properties. The focus of the document is on health and toxicological information.

48153 (PB–89-205124/XAB) **Injury and yield response of cotton to chronic doses of ozone and soil-moisture deficit.** Heagle, A.S.; Miller, J.E.; Heck, W.W.; Patterson, R.P. Agricultural Research Service, Albany, CA (USA). Western Utilization Research and Development Div. 1988. 12p. Available from NTIS, PC A03/MF A01.

Pub in Jnl. of Environmental Quality, Vol. 17, No. 4, 627-635(1988). See also PB–89-144422.

Plant response to ozone (O_3) is known to be modified by soil moisture deficit, which occurs in varying degrees during most growing seasons. Thus, the authors examined the response of cotton (Gossypium hirsutum) to different levels of seasonal stress by O_3 when grown at two soil moisture levels. The cotton was exposed for 12 h/d in open-top field chambers to five O_3 doses under well-watered (WW) conditions or under water-stressed (WS) conditions with periodic cycles of low soil moisture. Exposures began when the fifth leaves were expanding and continued for 124 d when most leaves were chlorotic or had abscised. Ozone caused significant yield loss in WW plots but not in WS plots. Results indicate that soil moisture deficit can decrease the impact of O_3 on cotton yield.

48154 (PB–89-861751/XAB) **Formaldehyde. January 1970-April 1989 (Citations from the NTIS data base). Report for January 1970-April 1989.** National Technical Information Service, Springfield, VA (USA). May 1989. 177p. Available from NTISPC N01/MF N01.

Supersedes PB–88-856729.

This bibliography contains citations concerning the health hazards of formaldehyde inhalation. Health-hazard evaluation reports of industrial sites are discussed, and the effects of formaldehyde on animals and humans are considered. Industrial-hygiene sampling methods and analytical methods to quantitate formaldehyde are also discussed. (This updated bibliography contains 303 citations, 42 of which are new entries to the previous edition.)

48155 (UCRL–21064) **Conventional weapons demilitarization: A health and environmental effects data base assessment: Methods for estimating multi-pathway exposures to environmental contaminants, Final report, Phase 2.** McKone, T.E. Lawrence Livermore National Lab., CA (USA). Jun 1988. 100p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. Order Number DE89016511/JAW. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This report describes a model that expresses human exposure using multiple exposure pathways linked to multiple environmental media. Starting with contaminant concentrations in air (as gases or attached to particles), water, and soil; the model links human exposure through inhalation, ingestion, and dermal absorption to concentrations in each environmental compartment. The concentration in a specific compartment is linked to exposure through a specific pathway using a pathway exposure factor (PEF). The PEF is a numerical expression that incorporates information on human physiology and lifestyle together with models of environmental partitioning into an expression that translates a unit concentration (mg/m^3 in air, mg/L in water, or mg/kg in soil) into a daily exposure in mg/kg-d for a specific pathway. Human, animal, and environmental data used in calculating PEFs are presented and discussed. The report provides a detailed derivation of PEFs for air/inhalation, air/ingestion, soil/inhalation, soil/ingestion, soil/dermal absorption, water/inhalation, water/ingestion, and water/dermal absorption pathways. The model is illustrated by sample applications of hypothetical arsenic, benzene, and trinitrotoluene (TNT) contamination. 42 refs., 4 figs., 20 tabs.

48156 **Disposing of the US chemical weapons stockpile. An approaching reality.** Carnes, S.A. (Oak Ridge National Lab., TN (USA)); Watson, A.P. *JAMA, Journal of the American Medical Association (USA)*, 262(5): 653-659 (4 Aug 1989).

A congressional mandate to dispose of the current US stockpile of lethal unitary weapons (Public Law 99-145, Department of Defense Authorization Act of 1986) has international implications and is responsible for a recent major assessment of available disposal alternatives. Eight installations in the continental United States currently host aging stockpiles of chemical warfare agents. The stockpiles are described, the toxicology and physical properties of each agent are characterized, disposal options considered by the US Army are identified, and the role of a programmatic health and environmental assessment in the decision-making process is outlined. Critical findings are that existing community emergency planning and preparedness are inadequate and that communication of risk information requires significant improvement. Measures are under way to address these needs. However, timely disposal of the stockpile entails less of a hazard than continued storage.

5604 Other Environmental Pollutant Effects

Refer also to citation(s) 47306

48157 (AD-A–207188/4/XAB) **Investigation of radiofrequency/microwave effects upon the central nervous system. Final report.** Shelton, W.W. Florida Inst. of Tech., Melbourne, FL (USA). Dept. of Electrical and Computer Engineering. 26 Jun 1980. 21p. Available from NTIS, PC A03/MF A01.

A study to determine the effect of pulsed electromagnetic energy upon brain calcium behavior was undertaken. An innovative approach for loading the cerebral tissues with radiocalcium was introduced. Intraventricular injections through the skull placed Ca-45 solution directly into the right lateral ventricle. Two hours later, companion frontal lobe samples were placed in separate glass breakers containing physiologic solution for a 20-min exposure to pulsed electromagnetic energy. An efflux value was calculated for each sample. A second experimental procedure involved whole-body irradiation of the animals two hours following the intraventricular injections. Animals were then irradiated with pulsed electromagnetic energy at a power density of 10 mW/cm squared, a pulse repetition frequency of 16 Hz, and carrier frequency of 2.45 GHz. Following exposure, frontal lobe and parieto-occipital tissue samples were taken and analysed for radioactivity. Statistical treatment of the first sets of experiments failed to reveal any perturbation in calcium efflux behavior. Data from the second set are still being evaluated.

48158 (AD-A–207275/9/XAB) **Analysis and evaluation of technical data on the photochromic and nonlinear optical properties of materials. Quarterly technical report No. 1.** Cozzens, R.F. George Mason Univ., Fairfax, VA (USA). 1 Mar 1989. 21p. Available from NTIS, PC A03/MF A01.

The overall goal of this relatively small contractural effort is to provide technical assistance to Dr. Frank Pattern (DARPA) in evaluating data on materials, especially polymers, that may be useful in the development of optical limiters for the protection of eyes and electrooptic sensors from exposure to damaging levels of laser radiation. A major task is to assist in the development of a predictive capability in assessing the viability of various protective approaches and to determine the theoretical limitations which may exist in the use of organic materials as optical switches and limiters. A search of the literature has been initiated in an attempt to gather into one table the magnitude of the nonlinear optical properties of various organic materials as a function of molecular structure. The search includes research activities supported by the Federal Government as well as the open literature.

48159 (AD-A–208198/2/XAB) **ELF (extremely low frequency) communications system ecological monitoring program: Summary of 1987 progress. Technical report, 1 January-31 December 1987.** Zapotosky, J.E. IIT Research Inst., Chicago, IL (USA). Apr 1989. 85p. (IIT-E–06595-3). Available from NTIS, PC A05/MF A01.

A long-term Ecological Monitoring Program is being conducted to monitor for possible effects from the operation of the U.S. Navy's extremely low-frequency (ELF) Communications System to resident biota and their ecological relationships. Monitoring studies were selected through a peer-reviewed, competitive bidding process in mid-1982, and work on most studies began in late summer of that year. Preliminary activities of the Program consisted of site selection, characterization of critical study aspects, and validation of assumptions made in original proposals. Subsequently, increasing emphasis has been placed on the collection of preoperational and operational data bases at the Michigan and Wisconsin Transmitting Facilities. The data bases are being used to make proposed spatial and/or temporal comparisons of biological and ecological variables. This report summarizes the progress of the Ecological Monitoring Program during 1987.

48160 (OH/RD–88-104-K) **Evaluation of IREQ [Research institute of Hydro Quebec] electromagnetic dosimeter performance.** Donnelly, K.E. Ontario Hydro Research Div., Toronto, ON (Canada). 1988. 35p. (MICROLOG–89-02618). Available from Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; $N/C; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1; $10 CAN.

The electromagnetic dosimeter developed by the research institute of Hydro Quebec (IREQ) has been evaluated under 16 categories of electronic performance. The dosimeter has high sensitivity, five channel design and data logging capability, and should fill the needs of many studies of occupational exposure to electromagnetic fields. For epidemiology, the time profile of field intensities makes possible the use of different exposure metrics, such as time-weighted average, peak value, or time above a threshold. While the dosimetere is well designed for use in epidemiological studies of electrical workers, several concerns about its performance exist: loss of sensitivity at low temperatures (from -12 C on); erratic readings when overloaded; readings in the top bin in occupational situations, leading to ambiguity on maximum fields encountered; and requirement to use a Hewlett-Packard computer. It is recommended that a proposed commercial version of the IREQ dosimeter be conditionally adopted, as it is expected that these concerns will be rectified. Similar performance tests will be necessary before final adoption because of the intended design changes. 8 refs., 14 figs., 2 tabs.

57 HEALTH AND SAFETY

Refer also to citation(s) 47650, 47651, 47652, 47653, 47654, 47656

58 GEOSCIENCES

5801 Geology and Hydrology

Refer also to citation(s) 47013, 47053

48161 (LA-UR–89-2664) **Effective stress model for partially and fully saturated rocks.** Dey, T.N. Los Alamos National Lab., NM (USA). [1989]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-890812–22: American Physical Society topical conference on shock compression of condensed matter, Albuquerque, NM (USA), 14-17 Aug 1989). Order Number DE89016590/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

An effective stress model which calculates the pressure-volume (P-V) and deviatoric stress response of partially and fully saturated rocks is described here. The model includes pore pressure effects on pore crushing and shear strength as well as effects of shear enhanced void collapse and shear caused dilatancy. The model can directly use tabular data for the P-V behavior of the rock solids and the water, and for the drained pore crushing behavior and shear strength, which simplifies model fitting. Phase transitions in the solids and vaporization of the water are also allowed. Use of the model is illustrated by an example of wave propagation in limestone. 6 refs., 4 figs.

5802 Geophysics

Refer also to citation(s) 47054, 47055, 48717

48162 (PNL–6956) **Earthquake recurrence rate estimates for eastern Washington and the Hanford Site.** Rohay, A.C. Pacific Northwest Lab., Richland, WA (USA). Aug 1989. 26p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-76RL01830. Order Number DE89016579/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The historical and instrumental records of earthquakes were used to estimate earthquake recurrence rates for input to a new seismic hazard analysis at the Hanford Site in eastern Washington. Two areas were evaluated, the eastern Washington region and the smaller Yakima Fold Belt, in which the Hanford Site is located. The completeness of a catalog of earthquakes was evaluated for earthquakes with Modified Mercalli Intensity (MMI) IV through VII. Only one MMI VII earthquake was reported in the last 100 years in eastern Washington. The reporting of MMI VI earthquakes appears to be complete for the last 80 years, and the reporting of MMI V earthquakes appears to be complete for the last 65 years. However, MMI IV earthquakes are consistently under-reported. For a limited set of earthquakes, both MMI and magnitude (M_L) have been reported. A plot of these data indicated that the Gutenberg-Richter relationship could be used to estimate earthquakes magnitudes from intensities. A recurrence curve for the historical earthquake data was calculated using the maximum likelihood method, including corrections for the width of the magnitude conversion. The slope of the recurrence curve (i.e., b-value) was found to be -1.15. Another catalog, one that listed instrumentally detected earthquakes from 1969 to the

present, was used to supplement the historical earthquake data. Magnitudes were determined using a coda-length method (M_c) that had been approximately calibrated to local magnitude M_L. For earthquakes whose M_c was between 3 and 5, the b-value ranged from -1.07 to - 1.12. 12 refs., 9 figs., 9 tabs.

48163 An algorithm for mesh simplification applied to fracture hydrology. Billaux, D. (Lawrence Berkeley Lab., CA (USA)); Fuller, P. *Mathematical Geology (USA)*, 21(2): 221-232 (Feb 1989). DOE Contract AC03-76SF00098.

Numerically generated discrete fracture networks are used to simulate the flow of water through rock fractures. The fractures are modeled as random assemblages of conductive elements in a non-conductive matrix. Because large numbers of fractures often are needed to represent fractured rock adequately, minimizing the required time and memory is crucial. For steady-state flow, any portion of the mesh that is linked to the rest of the mesh by only one point is a dead end and does not contribute to water flow. The removal of such dead-end clusters simplifies the mesh and therefore speeds up computation, without changing is response. An algorithm for removing these dead ends is described in detail. Its effectiveness is discussed with regard to the connectivity of a network.

5803 Mineralogy, Petrology, and Rock Mechanics

48164 (SAND-89-1019C) **Dynamic compression and release experiments on Indiana limestone.** Furnish, M.D. Sandia National Labs., Albuquerque, NM (USA). 1989. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-890812-25: American Physical Society topical conference on shock compression of condensed matter, Albuquerque, NM (USA), 14-17 Aug 1989). Order Number DE89016885/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A series of shock wave experiments designed to assess Hugoniot states, waveforms and release curves for water-saturated and dry Indiana Limestone has been conducted over the pressure range of 1-11 GPa. Strength effects dominate the response of the saturated samples below 4 GPa, with the shock velocity extrapolating to the ambient longitudinal velocity. Rarefaction shocks are observed at 3 and 4.5 GPa. The Hugoniot above 4 GPa is consistent with the formation of $CaCO_3 \cdot 6H_2O$ (ikaite), which is unstable below 0.5 GPa at room temperature. The dry limestone Hugoniot is slightly stiffer than predicted. Initial releases for both materials are nearly along the Hugoniot both at low and high pressures. 10 refs., 3 figs.

5804 Geochemistry

Refer also to citation(s) 46838, 47058, 47059, 47060, 47061, 47063, 47065

48165 (CONF-8609134–, pp. 3-9) **Multiple reaction path model describing mass transfer in geochemical systems.** Lichtner, P.C. (Univ. of California, Berkeley (USA)). Lawrence Livermore National Lab., CA (USA). 1986. From Workshop on geochemical modeling; Fallen Leaf Lake, CA (USA); 14-17 Sep 1986. In *Proceedings of the workshop on geochemical modeling.* Order Number DE89008807/JAW. Available from NTIS, PC A09/MF A01.

Geochemical reaction path models for open systems approximate interacting continua models describing flowing systems for sufficiently large Peclet numbers and surface controlled mineral dissolution rates. Two distinct time scales characterize mass transfer for such systems, related to fluid transport and mineral reaction rates along the flow path. The reaction path formulation is valid when the time required for a packet of fluid to traverse a characteristic distance along the flow path is much shorter than the time characterizing changes in mineral volume fraction, porosity, permeability and mineral surface area. The open system reaction path model results in a steady state regime in which the fluid composition and mineral reaction rates are constant in time, but may vary with distance. Mineral alteration zones are stationary throughout the steady state regime despite a constant fluid flow rate. Whenever a mineral in an alteration zone completely dissolves, or significant changes occur in reacting surface area, porosity or permeability, a new reaction path is formed. By considering a consecutive series of such paths, the time evolution of a geochemical system can be predicted over geologic time spans. It is suggested that a multiple reaction path approach may be applicable to the description of metasomatic processes and weathering phenomena including the formation of bauxite deposits. The issue of model verification and validation in light of this new interpretation of reaction path models is briefly discussed.

48166 (CONF-8609134–, pp. 20-26) **A theoretical basis for the coupling of chemical reactions to open system processes.** Perkins, E.H. (Alberta Research Council, Edmonton (Canada)). Lawrence Livermore National Lab., CA (USA). 1986. From Workshop on geochemical modeling; Fallen Leaf Lake, CA (USA); 14-17 Sep 1986. In *Proceedings of the workshop on geochemical modeling.* Order Number DE89008807/JAW. Available from NTIS, PC A09/MF A01.

In order to understand the processes involved in natural and industrial geological phenomenon involving an aqueous fluid and solid phases, the chemical interactions between the fluid and surrounding minerals must be known as functions of pressure, temperature, composition, and time. In addition to the boundary conditions, these processes are also dependent upon external sources of work, energy and mass (for example, injection wells). Equations have been derived which allow the chemical reactions between a fluid and solid phases to be evaluated in any open system. They are based on derivatives of the mass action and mass balance equations taken with respect to time and can be used to predict the distribution of mass at future times. These equations are coupled to modified version of the flow, heat transport and solute transport equations through the derivatives of the volume and number of moles of each of the solid phase, through derivatives of the molalities and partial molal volumes of the aqueous species, through the derivative of the total number of moles of water and through the amount of heat generated/consumed by the process. Using these equations, a computer program has been written and used to model various systems.

48167 (CONF-8609134–, pp. 27-33) **Calculations of geochemical mass transfer as a function of temperature and time.** Murphy, W.M. (Univ. of California, Berkeley (USA)). Lawrence Livermore National Lab., CA (USA). 1986. From Workshop on geochemical modeling; Fallen Leaf Lake, CA (USA); 14-17 Sep 1986. In *Proceedings of the workshop on geochemical modeling.* Order Number DE89008807/JAW. Available from NTIS, PC A09/MF A01.

Consideration of the temperature dependence of the rates of mineral dissolution permits kinetic calculations of geochemical mass transfer and transport in nonisothermal systems. Computations performed using a modified version of EQ6 show that differences in the variation of temperature with time significantly affect reaction paths. Nonisothermal kinetic reaction path models may be particularly useful in the understanding of the geochemical consequences of aqueous solutions flowing in thermal gradients.

48168 (CONF-8609134–, pp. 41-48) **Improvements in the solid solution modeling capabilities of EQ3/6.** Bourcier, W.L. (Lawrence Livermore National Lab., CA (USA)). Lawrence Livermore National Lab., CA (USA). 1986. From Workshop on geochemical modeling; Fallen Leaf Lake, CA (USA); 14-17 Sep 1986. In *Proceedings of the workshop on geochemical modeling.* Order Number DE89008807/JAW. Available from NTIS, PC A09/MF A01.

The EQ3/6 geochemical modeling codes have been expanded to include provision for the precipitation and dissolution of solid solution mineral phases in the calculation of water-rock reactions for both ideal and non-ideal solid solution models. The solid solution option can be used in both closed and open system modeling. In closed systems, the solid solution precipitates are assumed to completely re-equilibrate with the system at each step during the reaction. In open systems, a finite amount of solid solution which is precipitated at each step of reaction progress is removed from the system and not allowed to back-react with the fluid. The open system treatment can be used to model the zoning of solid solutions, which is commonly observed in nature. Sample calculations using the solid solution option in the simulation of the diagenetic changes in an arkosic sandstone show that including solid solutions as product phases results in increased stability of clays and carbonates during burial.

48169 (CONF-8609134–, pp. 146-153) **Computer modeling of the aqueous geochemistry of the Archean hydrosphere and the formation of banded iron formations.** Glassley, W.E. (Lawrence Livermore National Lab., CA (USA)); Jackson, K.J.; Bourcier, W.L. Lawrence Livermore National Lab., CA (USA). 1986. From Workshop on geochemical modeling; Fallen Leaf Lake, CA (USA); 14-17 Sep 1986. In *Proceedings of the workshop on geochemical modeling.* Order Number DE89008807/JAW. Available from NTIS, PC A09/MF A01.

Constraints on the composition of the hydrosphere during the Archean and early Proterozoic have been difficult to establish because of the lack of an unmetamorphosed sedimentary record. However, it may be possible to significantly restrict the range of possible values for the redox state and concentrations for some of the major components of the Archean hydrosphere by combining key observations from banded iron formations, evaporites, fluid inclusions, and paleosols. Recent developments in the capabilities of geochemical modeling codes have made it possible to accurately model such complex systems. Preliminary modeling efforts have concentrated on the geochemistry of the formation of Archean banded iron formations and their implications for the composition of the Archean hydrosphere. Results of the EQ3/6 modeling effort suggest that inorganic chemical process can result in the precipitation of phases that closely mimic the mineralogy of the iron-rich portions of banded iron formations. Mixing of ocean water with an acidic fluid that has been equilibrated with a basalt or komatiite results in a pH change and subsequent precipitation of iron-rich chemical sediment. A more neutral fluid cannot dissolve a high enough concentration of iron to contribute significantly to the formation of iron-rich sediments. The generation of acid waters responsible for banded iron formation may result either from terrestrial volcanic input into runoff or active seafloor vents in the banded iron formation basin. These mechanisms require no change in the oxygen fugacity of the local hydrosphere, and do not require biological activity.

48170 (CONF-8609134–, pp. 176-183) **Software for the computation and graphical display of intensive variable phase diagrams.** Perkins, E.H. (Alberta Research Council, Edmonton (Canada)); Berman, R.; Brown, T.H. Lawrence Livermore National Lab., CA (USA). 1986. From Workshop on geochemical modeling; Fallen Leaf Lake, CA (USA); 14-17 Sep 1986. In *Proceedings of the workshop on geochemical modeling.* Order Number DE89008807/JAW. Available from NTIS, PC A09/MF A01.

The use of intensive variable diagrams to portray the stability relationships of minerals, aqueous species and gases is one of the most critical tools available to evaluate the stability of natural assemblages. With the increasing accuracy and size of thermodynamic databases for minerals, gases and aqueous species, and the continually increasing speed and power of modern computers, it is now possible to interactively and quickly calculate diagrams relating all possible stability relationships for a given system. PT-SYSTEM and its derivatives (TX-SYSTEM, PX-SYSTEM, TFO2-SYSTEM, PA-SYSTEM, TA-SYSTEM and AA-SYSTEM) allow the calculation of phase diagrams as functions of pressure versus temperature, temperature versus fluid composition, pressure versus fluid composition, temperature versus oxygen fugacity, pressure versus activity of a specified component, temperature versus activity of a specified component, and activity versus activity of two different components. By default, only the stable diagram is calculated and is presented in tabular form and as a plot. All curves are labelled with the correct assemblage on each side of the curve. The programs are versatile with many different run time options, including: projection from a given phase or assemblage; limiting the calculation of curves to those which contain a given phase or assemblage; inclusion of meta-stable equilibria, and the use of various solid solution models for solids and equations of state of gases. It includes equations for disorder, polymorphic transitions as well as extended heat capacity functions and volumetric equations of state for solids.

5805 Oceanography

48171 (ORNL/FTR–3171) **[North Atlantic seasonal ecosystem model]: Foreign trip report, January 16–21, 1989.** Fasham, M.J.R. Oak Ridge National Lab., TN (USA). 6 Feb 1989. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017369/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The results of version 1 of the three-dimensional North Atlantic Seasonal Ecosystem Model were analyzed, and it was agreed that the resulting monthly distributions of phytoplankton and nitrate were in good qualitative agreement with observations in the equatorial zone and north of 30° N. However, in the latitudinal band between 15° N and 30° N the model greatly underestimated the primary production and biomass. It is believed that this problem arises because of the underestimation of regenerated production. Ways of correcting this fault in the model were then discussed using the experience gained by Drs. Fasham and Ducklow from running a 1- dimensional model, and it was agreed that the key lay in increasing the recycling of detritus within the mixed layer. Finally, a complete review of the ecosystem model equations and parameters was made, the version 2 model was redefined, and a work plan for the next six months was agreed upon.

64 PHYSICS I

48172 (INIS-mf–11515) **Annual convention 1989 of the Austrian physical society.** Johannes Kepler Univ., Linz (Austria). 1989. 145p. (In German, English). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

This is a collection of pre-conference abstracts of 205 oral representations and posters, in the fields of: atomic, molecular and plasma physics; solid state physics; nuclear and particle physics; high polymer physics; medical- and biophysics. 69 of them are in INIS scope. (qui).

48173 (INIS-SU–113/A) **Experimental and theoretical physics. Collection.** Kratkie soobshcheniya po fizike. v. 1. AN SSSR, Moscow (USSR). Fizicheskij Inst. 1989. 46p. (T–23539). Order Number DE89018003/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Individual papers have been processed separately for inclusion in the data base. (DLC)

6401 Astrophysics and Cosmology

Refer also to citation(s) 47016, 47850, 48232, 48240, 48563, 48677

48174 (AD-A–206665/2/XAB) **Differences between line bisectors in quiet and active sun.** Marmolino, C.; Roberti, G.; Severino, G. Air Force Geophysics Lab., Hanscom AFB, MA (USA). 1986. 5p. (AFGL-TR–89-0054). Available from NTIS, PC A02/MF A01.

This study presents the results from the synthetic analysis of atomic line profiles formed on the sun in hot magnetic regions and cool non-magnetic regions.

48175 (AD-A–207311/2/XAB) **Equilibrium of solar coronal arcades. Interim report.** Finn, J.M.; Chen, J. Naval Research Lab., Washington, DC (USA). 27 Mar 1989. 70p. (NRL-MR–6402). Available from NTIS, PC A04/MF A01.

Properties of two-dimensional straight (symmetric in z) magnetic arcade equilibria in the solar corona are studied within the framework of magnetohydrodynamics. Sequences of MHD equilibria are obtained by solving the Grad-Shafranov equation with the footprint displacement and the entropy prescribed. It is shown that no multiple solutions, or bifurcations, result. This is to be contrasted with the approach of prescribing the axial magnetic field Bz(psi) or pressure p(psi), in which bifurcations do occur. The physical conditions for which the footprint displacement or entropy, as opposed to Bz or p, must be specified are discussed. It is argued that these conditions are more likely to occur in the corona than those conditions under which Bz and p may be prescribed. The lack of bifurcations indicates that equilibrium will not be lost as the footprint displacement or entropy is increased. The limiting configurations for infinite footprint displacement and infinite entropy are also discussed. It is shown that although the current density does become somewhat

peaked, the total current in the peak region decreases as the system is sheared (or heated). In fact, the current in this peak region contains a rapidly decreasing fraction of the total current so that the limiting configuration is not one in which the current is concentrated into a current sheet.

48176 (CONF-8902117–2) **An atom probe study of phase decomposition in three iron meteorites.** Miller, M.K.; Russell, K.F. Oak Ridge National Lab., TN (USA). [1989]. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From Symposium on physical metallurgy of controlled expansion invar-type alloys; Las Vegas, NV (USA); 28 Feb 1989. Order Number DE89017581/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

An atom probe field-ion microscopy characterization of the Cape York, Twin City and Santa Catharina iron-nickel meteorites has been performed. This investigation has revealed that the taenite, corresponding to an interface region between the cloudy zone and the clear taenite 2 (CT2) region in the Cape York meteorite and the matrix of the Twin City and Santa Catharina meteorites, has phase separated to form an ultra-fine scale duplex microstructure. The composition of these two phases was determined to be 50 at. % Ni and approximately 15 at. % Ni. These compositions correspond to the equiatomic FeNi $L1_0$-ordered phase and a disordered face centered cubic phase. 38 refs., 16 figs., 3 tabs.

48177 (INIS-mf–11514, pp. 603-615) **Verification of high energy interaction model using data on cosmic rays in the atmosphere.** Kempa, J. (Lodz Univ. (Poland). Inst. Fizyki); Wdowczyk, J. Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

The energy spectra of high energy muons and hadrons are compared with the predictions based on the two component model of the Galactic cosmic rays. Excellent agreement of the predictions and experimental data is found. 20 refs., 4 figs. (author).

48178 (INIS-mf–11515, pp. 14) **Nuclear astrophysics: from Big Bang to supernovae.** Rolfs, C. (Muenster Univ. (Germany, F.R.). Inst. fuer Kernphysik). Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48179 (INIS-mf–11537, pp. 27) **Laser Doppler measurements of corona wind velocity.** Woolsey, G.A. (New England Univ., Armidale (Australia). Dept. of Physics); Woerner, M.C.H. Australian Inst. of Nuclear Science and Engineering, Lucas Heights (Australia). 1989. (CONF-8902130–: 17. AINSE plasma physics conference, Lucas Heights (Australia), 6-8 Feb 1989). In *17th AINSE plasma physics conference: conference handbook.* Order Number DE90600936/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

Abstract only.

48180 (INIS-mf–11537, pp. 75) **Jupiter Torus as a plasma and electromagnetic waveguide.** Boundy, W.S. (South Australian Inst. of Tech., Adelaide (Australia). School of Physics). Australian Inst. of Nuclear Science and Engineering, Lucas Heights (Australia). 1989. (CONF-8902130–: 17. AINSE plasma physics conference, Lucas Heights (Australia), 6-8 Feb 1989). In *17th AINSE plasma physics conference: conference handbook.* Order Number DE90600936/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

Abstract only.

48181 (INIS-SU–113/A, pp. 35-37) **Wave sources of momentum and heat in solar wind.** Chashej, I.V. AN SSSR, Moscow (USSR). Fizicheskij Inst. 1989. (In Russian). (T–23539). In *Experimental and theoretical physics. Collection.* Order Number DE89018003/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Kratkie soobshcheniya po fizike.; v. 1.

Sources of momentum and heat in solar wind related to nonlinear damping of Alfven waves are considered. It is shown that account of the sources permits to explain rapid acceleration of plasma and additional heating of ions in a narrow area adjoining the special point. 5 refs.

48182 (KFKI–1989-36/C) **P/Halley the model comet, in view of the imaging experiment aboard the VEGA spacecraft.** Szego, K. Hungarian Academy of Sciences, Budapest (Hungary). Central Research Inst. for Physics. [1989]. 11p. Sponsored by Central Research Institute for Physics, Budapest, Hungary. (CONF-8904266–1: Conference on comets in Post-Halley area, Bamberg (Germany, F.R.), 24-28 Apr 1989). Order Number DE89016049/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI.

In this paper those results of the VEGA imaging experiments are summarized which probably have general validity for any comet. Shape, size, surface structure, jet activity, rotations pattern are considered in this respect. It is pointed out that imaging data provide indispensable information to an understanding of cometary activity. 27 refs.

48183 (LA-UR–89-2482) **The status of CYGNUS experiment: Past, present, and future.** Haines, T.J.; Berley, D.; Chang, C.Y.; Dingus, B.L.; Goodman, J.A.; Stark, M.; Burman, R.L.; Cady, D.R.; Hoffman, C.M.; Lloyd-Evans, J.; Nagle, D.E.; Potter, M.; Sandberg, V.D.; Wilkinson, C.A.; Alexandreas, D.E.; Allen, R.C.; Biller, S.; Dion, G.M.; Lu, XLos Alamos National Lab., NM (USA). 1989. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-8905193–2: Workshop on physics and experimental techniques of high energy neutrinos and VHE and UHE gamma-ray particle astrophysics, Little Rock, AR (USA), 11-13 May 1989). Order Number DE89015299/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The CYGNUS experiment, located in Los Alamos, NM, has been continuously operating since April 2, 1986. The experiment consists of an air shower array and an associated 44 m^2 muon detector; its large size, good angular resolution, muon detection, and low energy threshold make it a unique experiment among those currently operating. The experiment has undergone continuous expansion in several stages since it began operation. The experiment, its expansion, and further plans for the further will be described. 6 refs., 9 figs.

48184 (LA-UR–89-2686) **Hybrid simulations of a curved shock.** Thomas, V.; Winske, D. Los Alamos National Lab., NM (USA). 1989. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-890931–4: 13. conference on the numerical simulation of plasmas, Santa Fe, NM (USA), 17-20 Sep 1989). Order Number DE89016591/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

SOLAR WIND/simulation; SHOCK WAVES; SIMULATION; SUPERSONIC FLOW; MAGNETOHYDRODYNAMICS; FLUID MECHANICS; WAVE PROPAGATION; ALFVEN WAVES; NUMERICAL SOLUTION

48185 (LA-UR–89-2961) **Effects of main-sequence mass loss on the turnoff ages of population 1 clusters.** Guzik, J.A. Los Alamos National Lab., NM (USA). 1989. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-8906206–1: 5. IAP astrophysics meeting on astrophysical ages and dating methods, Paris (France), 26-29 Jun 1989). Order Number DE89016755/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Willson, Bowen, and Struck-Marcell have proposed that stars of spectral types A through early-G lose a significant portion of their mass during the early main-sequence phase. The proposed mass loss is driven by pulsation, and facilitated by rapid rotation. One implication of this hypothesis is that the main-sequence turnoff is an invalid indicator of cluster age, as present turnoff stars may have had higher projenitor masses; hence clusters appear older than they actually are. This paper presents examples of cluster HR diagrams synthesized with mass-losing stars of solar metallicity, initial masses 1-2 $M_{\{circ_dot\}}$, and exponentially-decreasing mass-loss

rates with e-folding times 1-2 Gyr. The increases in apparent turnoff age of Pop. I clusters, and the potential of the hypothesis to account for blue stragglers as normal stars that have not lost mass (or lost mass more slowly) are discussed. 9 refs., 6 figs.

48186 (LA-UR–89-2962) **Effects of main-sequence mass loss on the turnoff ages of globular clusters.** Guzik, J.A. Los Alamos National Lab., NM (USA). 1989. 9p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-8906206–2: 5. IAP astrophysics meeting on astrophysical ages and dating methods, Paris (France), 26-29 Jun 1989). Order Number DE89016784/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Willson, Bowen, and Struck-Marcell have proposed that globular cluster main-sequence turnoff ages can be reconciled with the lower ages of the Galaxy and universe deduced from other methods by incorporating an epoch of early main-sequence mass-loss by stars of spectral types A through early-F. The proposed mass loss is pulsation-driven, and facilitated by rapid rotation. This paper presents stellar evolution calculations of Pop. II ($Z = 0.001$) mass-losing stars of initial mass 0.8 to 1.6 $M_{\odot}$, with exponentially-decreasing mass loss rates of e-folding times 0.5 to 2.0 Gyr, evolving to a final mass of 0.7 $M_{\odot}$. The calculations indicate that a globular cluster with apparent turnoff age 18 Gyr could have an actual age as low as ~12 Gyr. Observational implications that may help to verify the hypothesis, e.g. low C/N abundance ratios among red giants following first dredge-up, blue stragglers, red giant deficiencies, and signatures in cluster mass/luminosity functions, are also discussed.25 refs., 4 figs., 3 tabs.

48187 (N–89-19222) **Correlation between x-ray flux and rotational acceleration in Vela X-1. Final technical report.** Deeter, J.E.; Boynton, P.E.; Shibazaki, N.; Hayakawa, S.; Nagase, F. Washington Univ., Seattle, WA (USA). Feb 1989. 54p. (NASA-CR–184803;NAS–1.26:184803). Available from NTIS, PC A04/MF A01.

The results of a search for correlations between X-ray flux and angular acceleration for the accreting binary pulsar Vela X-1 are presented. Results are based on data obtained with the Hakucho satellite during the interval 1982 to 1984. In undertaking this correlation analysis, it was necessary to modify the usual statistical method to deal with conditions imposed by generally unavoidable satellite observing constraints, most notably a mismatch in sampling between the two variables. The results are suggestive of a correlation between flux and the absolute value of the angular acceleration, at a significance level of 96 percent. The implications of the methods and results for future observations and analysis are discussed.

48188 (N–89-20875) **Forbidden coronal iron line emission in the Puppis A shock front: The effect of inhomogeneities.** Teske, R.G.; Petre, R. National Aeronautics and Space Administration, Greenbelt, MD (USA). Goddard Space Flight Center. 1986. 27p. (NASA-TM–89284;NAS–1.15:89284). Available from NTIS, PC A03/MF A01.

We have obtained CCD images of the shock front at the eastern rim of Puppis A in (Fe X) lambda 6374 and (Fe XIV) lambda 5303 and have compared the optical data to Einstein HRI soft X-ray data. The observed part of the remnant is complex, containing density irregularities. Optical and X-ray data are consistent in showing a nearly flat gradient of ionization behind the shock. To determine conditions in the shock, scans of surface brightness across it in the optical lines were compared to surface brightnesses predicted by idealized Sedov models. We were unable to match both the red and green line scans by a simple, single-component model, and have ascribed the failure to the presence of the density inhomogeneities. Our result has important implications for the determination of SNR shock front models by means of fitting X-ray data with Sedov models.

48189 (N–89-20880) **Effects of Cosmions upon the structure and evolution of very low mass stars.** Deluca, E.E.; Griest, K.; Rosner, R.; Wang, J. Chicago Univ., IL (USA). Feb 1989. 8p. (NASA-CR–182958;NAS–1.26:182958;FERMILAB-PUB–89/49-A). Available from NTIS, PC A02/MF A01.

A number of recent studies have suggested that cosmions, or WIMPS, may play an important role in the energetics of the solar interior; in particular, it has been argued that these hypothetical particles may transport sufficient energy within the nuclear-burning solar core so as to depress the solar core temperature to the point of resolving the solar neutrino problem. Solutions to the solar neutrino problem have proven themselves to be quite nonunique, so that it is of some interest whether the cosmion solution can be tested in some independent manner. It is argued that if cosmions solve the solar neutrino problem, then they must also play an important role in the evolution of low mass main sequence stars; and, second, that if they do so, then a simple (long mean free path) model for the interaction of cosmions with baryons leads to changes in the structure of the nuclear-burning core which may be in principal observable. Such changes include suppression of a fully-convective core in very low mass main sequence stars; and a possible thermal runaway in the core of the nuclear burning region. Some of these changes may be directly observable, and hence may provide independent constraints on the properties of the cosmions required to solve the solar neutrino problem, perhaps even ruling them out.

48190 (N–89-20896) **Fragmentation of cosmic-string loops.** York, T. Fermi National Accelerator Lab., Batavia, IL (USA). Jan 1989. 17p. (NASA-CR–184892;NAS–1.26:184892;FERMILAB-PUB–89/32-A). Available from NTIS, PC A03/MF A01.

The fragmentation of cosmic string loops is discussed, and the results of a simulation of this process are presented. The simulation can evolve any of a large class of loops essentially exactly, including allowing fragments that collide to join together. Such reconnection enhances the production of small fragments, but not drastically. With or without reconnections, the fragmentation process produces a collection of nonself-intersecting loops whose typical length is on the order of the persistence length of the initial loop.

48191 (N–89-21287, pp. 8-9) **Cratering record in the inner solar system: Implications for earth.** Barlow, N.G. Lunar and Planetary Inst., Houston, TX (USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird, UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history: An interdisciplinary conference on impacts, volcanism, and mass mortality.* Available from NTIS, PC A11/MF A01.

Internal and external processes have reworked the Earth's surface throughout its history. In particular, the effect of meteorite impacts on the early history of the earth is lost due to fluvial, aeolian, volcanic and plate tectonic action. The cratering record on other inner solar system bodies often provides the only clue to the relative cratering rates and intensities that the earth has experienced throughout its history. Of the five major bodies within the inner solar system, Mercury, Mars, and the Moon retain scars of an early episode of high impact rates. The heavily cratered regions on Mercury, Mars, and the Moon show crater size-frequency distribution curves similar in shape and crater density, whereas the lightly cratered plains on the Moon and Mars show distribution curves which, although similar to each other, are statistically different in shape and density from the more heavily cratered units. The similarities among crater size-frequency distribution curves for the Moon, Mercury, and Mars suggest that the entire inner solar system was subjected to the two populations of impacting objects but Earth and Venus have lost their record of heavy bombardment impactors. Thus, based on the cratering record on the Moon, Mercury, and Mars, it can be inferred that the Earth experienced a period of high crater rates and basin formation prior to about 3.8 BY ago. Recent studies have linked mass extinctions to large terrestrial impacts, so life forms were unable to establish themselves until impact rates decreased substantially and terrestrial conditions became more benign. The possible periodicity of mass extinctions has led to the theory of fluctuating impact rates due to comet showers in the post heavy bombardment period. The active erosional environment on the Earth complicates attempts to verify these showers by erasing geological evidence of older impact craters.

48192 (N–89-21287, pp. 26-27) **Risk to civilization: A planetary science perspective.** Chapman, C.R.; Morrison, D. Lunar and Planetary Inst., Houston, TX (USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird, UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history:*

An interdisciplinary conference on impacts, volcanism, and mass mortality. Available from NTIS, PC A11/MF A01.

One of the most profound changes in our perspective of the solar system resulting from the first quarter century of planetary exploration by spacecraft is the recognition that planets, including Earth, were bombarded by cosmic projectiles for 4.5 aeons and continue to be bombarded today. Although the planetary cratering rate is much lower now than it was during the first 0.5 aeons, sizeable Earth-approaching asteroids and comets continue to hit the Earth at a rate that poses a finite risk to civilization. The evolution of this planetary perspective on impact cratering is gradual over the last two decades. It took explorations of Mars and Mercury by early Mariner spacecraft and of the outer solar system by the Voyagers to reveal the significance of asteroidal and cometary impacts in shaping the morphologies and even chemical compositions of the planets. An unsettling implication of the new perspective is addressed: the risk to human civilization. Serious scientific attention was given to this issue in July 1981 at a NASA-sponsored Spacewatch Workshop in Snowmass, Colorado. The basic conclusion of the 1981 NASA sponsored workshop still stands: the risk that civilization might be destroyed by impact with an as-yet-undiscovered asteroid or comet exceeds risk levels that are sometimes deemed unacceptable by modern societies in other contexts. Yet these impact risks have gone almost undiscussed and undebated. The tentative quantitative assessment by some members of the 1981 workshop was that each year, civilization is threatened with destruction with a probability of about 1 in 100,000. The enormous spread in risk levels deemed by the public to be at the threshold of acceptability derives from a host of psychological factors that were widely discussed in the risk assessment literature.

48193 (N–89-21287, pp. 34-35) **Noble metals in mid-ocean ridge volcanism: A significant fractionation of gold with respect to platinum group metals.** Crocket, J.H. Lunar and Planetary Inst., Houston, TX (USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird, UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history: An interdisciplinary conference on impacts, volcanism, and mass mortality.* Available from NTIS, PC A11/MF A01.

Hydrothermal precipitates, black smoker particulate, and massive sulphide dredge samples from the Explorer Ridge on the Juan de Fuca Plate and the TAG hydrothermal area on the Mid-Atlantic Ridge were analyzed for selected noble metals including Au, Ir and Pd by radiochemical neutron activation analysis. The preliminary results indicate that gold contents may reach the ppm range although values in the neighborhood of 100 to 200 ppb are more typical. The platinum group elements (PGE) represented by Ir and Pd are typically less than 0.02 ppb and less than 2 ppb respectively. These abundances represent a significant enrichment of gold relative to the PGE in comparison with average noble metal abundances in mid-ocean ridge basalts (MORB). A partial explanation of this distinctive fractionation can be found in the concepts of sulfur-saturation of basic magma in mid-ocean ridge (MOR) settings, and the origin of MOR hydrothermal fluids. Experimental and petrological data suggest that MORBs are sulfur-saturated at the time of magma generation and that an immiscible sulfide component remains in the mantle residue. Hence, MORBs are noble metal-poor, particularly with respect to PGE. Consequently, black smoker fluids can be expected to reflect the low Ir and Pd contents of the rock column. The average Au content of MORB is 1.3 ppb, and so the rock column is not significantly enriched in Au. The generation of fluids which precipitate solids with 200 ppb Au is apparently dependent on highly efficient fluid chemistry to mobilize Au from the rock column, high Au solubility in seawater hydrothermal fluids and efficient precipitation mechanisms to coprecipitate Au on Fe, Zn and Cu sulfides. Significant differences in these parameters appear to be the ultimate cause of the strong Au-PGE fractionation in the MOR setting.

48194 (N–89-21287, pp. 38-39) **Explosive volcanism, shock metamorphism and the K-T boundary.** Desilva, S.L.; Sharpton, V.L. Lunar and Planetary Inst., Houston, TX (USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird, UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history: An interdisciplinary conference on impacts, volcanism, and mass mortality.* Available from NTIS, PC A11/MF A01.

The issue of whether shocked quartz can be produced by explosive volcanic events is important in understanding the origin of the K-T boundary constituents. Proponents of a volcanic origin for the shocked quartz at the K-T boundary cite the suggestion of Rice, that peak overpressures of 1000 kbars can be generated during explosive volcanic eruptions, and may have occurred during the May, 1980 eruption of Mt. St. Helens. Attention was previously drawn to the fact that peak overpressures during explosive eruptions are limited by the strength of the rock confining the magma chamber to less than 8 kbars even under ideal conditions. The proposed volcanic mechanisms for generating pressures sufficient to shock quartz are further examined. Theoretical arguments, field evidence and petrographic data are presented showing that explosive volcanic eruptions cannot generate shock metamorphic features of the kind seen in minerals at the K-T boundary.

48195 (N–89-21287, pp. 42-43) **Sudbury Structure (Ontario, Canada) and Vredefort Structure (South Africa): A comparison.** Dressler, B.O.; Reimold, W.U. Lunar and Planetary Inst., Houston, TX (USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird, UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history: An interdisciplinary conference on impacts, volcanism, and mass mortality.* Available from NTIS, PC A11/MF A01.

Both the Sudbury Structure (SS) and the Witwatersrand Basin surrounding the Vredefort Structure (VS) host some of the most important base and precious metal deposits on earth. In both structures Precambrian igneous, sedimentary and volcanic rocks were affected by the structure forming process, either meteorite impact or endogenic explosion, or as some VS workers propose, by high strain tectonics. Besides these general features there are some geological and geophysical characteristics that are strikingly similar in both structures. There are, however, some obvious differences. Directly related to the structure forming processes are breccias in the footwall rocks of both structures. Pseudotachylite breccias occurring in both structures display great similarities. Chemical and physical characteristics of the pseudotachylites are similar in both structures. Both structures are characterized by overturned collar rocks, not evident everywhere around the SS. The VS is rimmed by an up or overturned collar of sediments and volcanics of the Witwatersrand, Ventersdorp and Transvaal Supergroups. Drilling information proved that the strata of the Witwatersrand Supergroup in the south of the VS are lying horizontally. Shockmetamorphic features such as planar microdeformations in rock forming minerals and shatter cones are present in both structures in the footwall rocks and in the SS also in the breccias of the OF. Both structures have large geophysical anomalies associated with them. In both structures the anomalies were interpreted as being caused by mafic-ultramafic complexes underlying the structures.

48196 (N–89-21287, pp. 48) **Iridium emissions from Hawaiian volcanoes.** Finnegan, D.L.; Zoller, W.H.; Miller, T.M. Lunar and Planetary Inst., Houston, TX (USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird, UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history: An interdisciplinary conference on impacts, volcanism, and mass mortality.* Available from NTIS, PC A11/MF A01.

Abstract Only.

Particle and gas samples were collected at Mauna Loa volcano during and after its eruption in March and April, 1984 and at Kilauea volcano in 1983, 1984, and 1985 during various phases of its ongoing activity. In the last two Kilauea sampling missions, samples were collected during eruptive activity. The samples were collected using a filterpack system consisting of a Teflon particle filter followed by a series of 4 base-treated Whatman filters. The samples were analyzed by INAA for over 40 elements. As previously reported in the literature, Ir was first detected on particle filters at the Mauna Loa Observatory and later from non-erupting high temperature vents at Kilauea. Since that time Ir was found in samples collected at Kilauea and Mauna Loa during fountaining activity as well as after eruptive activity. Enrichment factors for Ir in the volcanic fumes range from 10,000 to 100,000 relative to BHVO.

Charcoal impregnated filters following a particle filter were collected to see if a significant amount of the Ir was in the gas phase during sample collection. Iridium was found on charcoal filters collected close to the vent, no Ir was found on the charcoal filters. This indicates that all of the Ir is in particulate form very soon after its release. Ratios of Ir to F and Cl were calculated for the samples from Mauna Loa and Kilauea collected during fountaining activity. The implications for the KT Ir anomaly are still unclear though as Ir was not found at volcanoes other than those at Hawaii. Further investigations are needed at other volcanoes to ascertain if basaltic volcanoes other than hot spots have Ir enrichments in their fumes.

48197 (N–89-21287, pp. 52-53) **Geological remote sensing signatures of terrestrial impact craters.** Garvin, J.B.; Schnetzler, C.; Grieve, R.A.F. Lunar and Planetary Inst., Houston, TX (USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird, UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history: An interdisciplinary conference on impacts, volcanism, and mass mortality.* Available from NTIS, PC A11/MF A01.

Geological remote sensing techniques can be used to investigate structural, depositional, and shock metamorphic effects associated with hypervelocity impact structures, some of which may be linked to global Earth system catastrophies. Although detailed laboratory and field investigations are necessary to establish conclusive evidence of an impact origin for suspected crater landforms, the synoptic perspective provided by various remote sensing systems can often serve as a pathfinder to key deposits which can then be targetted for intensive field study. In addition, remote sensing imagery can be used as a tool in the search for impact and other catastrophic explosion landforms on the basis of localized disruption and anomaly patterns. In order to reconstruct original dimensions of large, complex impact features in isolated, inaccessible regions, remote sensing imagery can be used to make preliminary estimates in the absence of field geophysical surveys. The experienced gained from two decades of planetary remote sensing of impact craters on the terrestrial planets, as well as the techniques developed for recognizing stages of degradation and initial crater morphology, can now be applied to the problem of discovering and studying eroded impact landforms on Earth. Preliminary results of remote sensing analyses of a set of terrestrial impact features in various states of degradation, geologic settings, and for a broad range of diameters and hence energies of formation are summarized. The intention is to develop a database of remote sensing signatures for catastrophic impact landforms which can then be used in EOS-era global surveys as the basis for locating the possibly hundreds of missing impact structures.

48198 (N–89-21287, pp. 78-79) **Provenance of the K/T boundary layers.** Hildebrand, A.R.; Boynton, W.V. Lunar and Planetary Inst., Houston, TX (USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird, UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history: An interdisciplinary conference on impacts, volcanism, and mass mortality.* Available from NTIS, PC A11/MF A01.

An array of chemical, physical and isotopic evidence indicates that an impact into oceanic crust terminated the Cretaceous Period. Approximately 1500 cu km of debris, dispersed by the impact fireball, fell out globally in marine and nonmarine environments producing a 2 to 4 mm thick layer (fireball layer). In North American locales, the fireball layer overlies a 15 to 25 mm thick layer of similar but distinct composition. This 15 to 25 mm layer (ejecta layer) may represent approximately 1000 cu km of lower energy ejecta from a nearby impact site. Isotopic and chemical evidence supports a mantle provenance for the bulk of the layers. The extraordinary REE pattern of the boundary clays was modelled as a mixture of oceanic crust, mantle, and approximately 10 percent continental material. The results are presented. If the siderophiles of the ejecta layer were derived solely from the mantle, a test may be available to see if the siderophile element anomaly of the fireball layer had an extraterrestrial origin. Radiogenic Os-187 is depleted in the mantle relative to an undifferentiated chondritic source. Os-187/Os-186 ratios of 1.049 and 1.108 were calculated for the ejecta and fireball layers, respectively.

48199 (N–89-21287, pp. 95-96) **Kara and Ust-Kara impact structures (USSR) and their relevance to the K/T boundary event.** Koeberl, C.; Nazarov, M.A.; Harrison, T.M.; Sharpton, V.L.; Murali, A.V.; Burke, K. Lunar and Planetary Inst., Houston, TX (USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird, UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history: An interdisciplinary conference on impacts, volcanism, and mass mortality.* Available from NTIS, PC A11/MF A01.

The Kara and Ust-Kara craters are twin impact structures situated at about 69 deg 10 min N; 65 deg 00 min E at the Kara Sea. For Kara a diameter of about 55 km would be a very conservative estimate, and field observations indicate a maximum current diameter of about 60 km. The diameter of Ust-Kara has to be larger than 16 km. A better estimate might be 25 km but in all likelihood it is even larger. Suevites and impactites from the Kara area have been known since the beginning of the century, but had been misidentified as glacial deposits. Only about 15 years ago the impact origin of the two structures was demonstrated, following the recognition of shock metamorphism in the area. The composition of the target rocks is mirrored by the composition of the clasts within the suevites. In the southern part of Kara, Permian shales and limestones are sometimes accompanied by diabasic dykes, similar to in the central uplift. Due to the high degree of shock metamorphism the shocked magmatic rocks are not easily identified, although most of them seem to be of diabasic or dioritic composition. The impact melts (tagamites) are grey to dark grey fine grained crystallized rocks showing very fine mineral components and are the product of shock-melting with later recrystallization. The impact glasses show a layered structure, inclusions, and vesicles, and have colors ranging from translucent white over brown and grey to black. A complete geochemical characterization of the Kara and Ust-Kara impact craters was attempted by analyzing more than 40 samples of target rocks, shocked rocks, suevites, impact melts, and impact glasses for major and trace elements.

48200 (N–89-21287, pp. 97-98) **Isotopic investigations in the area of the Tunguska catastrophe in 1908 year.** Kolesnikov, E.M. Lunar and Planetary Inst., Houston, TX (USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird, UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history: An interdisciplinary conference on impacts, volcanism, and mass mortality.* Available from NTIS, PC A11/MF A01.

The hypotheses of the annihilation and thermonuclear character of the Tunguska explosion have been tested by measuring inductive Ar-39 radioactivity from K and Ca in rocks and soil under the explosion epicentrum. Ar-39 was not detected though its estimated radioactivity was expected to be 100 times higher than the radiometrical plant sensitivity. These results testify against the nuclear nature of the Tunguska explosion. The contents of 11 elements in the ultrasmall quantity of matter of the silicate microspherules isolated from catastrophe peat layer at the explosion site were measured by method of neutron activation analysis. It was demonstrated that the enrichment of microspherules by light and volatile elements (Al, Na, Zn, Cs) and the impoverishment by more heavy and hard volatile ones (Fe, Co, Sc). It was shown that the microspherules were not the product of differentiation of the terrestrial soil or of an ordinary meteorite material. It was demonstrated that Pb isotopic content in catastrophe peat layer had more Pb-204, Pb-207, Pb-208 than Pb-206 as compared with Pb isotopic content of other peat layers and common Pb in this area. In the peat column taken at the Ostraya hill area in three nearcatastrophe layers, small increases of isotopic C-13 was determined. Isotopic C effect in the peat layer is confirmed also for the North peatbog. Observed isotopic changes are not accounted for by climatic changes or other physico-chemical reasons. They seem to be related to preservation in the peat of matter resembling carbonaceous chrondrites of the CI type or more probably of cometary matter enriched much more in volatile elements.

48201 (N–89-21287, pp. 108) **Evidence for and implications of an Early Archean terrestrial impact record.** Lowe, D.R.; Byerly, G.R. Lunar and Planetary Inst., Houston, TX

(USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird, UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history: An interdisciplinary conference on impacts, volcanism, and mass mortality*. Available from NTIS, PC A11/MF A01.

Early Archean, 3.5 to 3.2 Ga, greenstone sequences in South Africa and Western Australia contain a well-preserved record of early terrestrial meteorite impacts. The main impact-produced deposits are layers, 10 cm to over 1 m thick, composed largely of sand-sized spherules, 0.1 to 4 mm in diameter. The beds studied to date show an assemblage of features indicating formation by the fall of debris from impact-generated ejecta clouds. Some presented data effectively rule out normal magmatic or sedimentary processes in the origin of these units and provide substantial support for an origin by large impacts on the early earth. The presence of at least four, remarkably thick, nearly pure spherule layers suggests that smaller-scale impact deposits may be even more abundant in these sequences. The existence of a well-preserved Archean terrestrial impact record suggests that a direct source of evidence is available regarding a number of important aspects of early earth history.

48202 (N–89-21287, pp. 109-110) **Magnetic reversal spurts: Rain gauges for comet showers.** Lutz, T.M. Lunar and Planetary Inst., Houston, TX (USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird, UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history: An interdisciplinary conference on impacts, volcanism, and mass mortality*. Available from NTIS, PC A11/MF A01.

Abrupt increases in the rate of magnetic reversals (magnetic reversal spurts) were first studied by many others. They hypothesized that spurts result from increased turbulence in the earth's core dynamo during episodes of intense bolide bombardment of the earth. Mechanisms for creating episodes of intense bombardment of the earth involve gravitational perturbation of the Oort cloud of comets, either by a hidden planet, a solar companion, or massive matter in the galactic plane. Herein, the time variation in reversal rate is analyzed using methods of statistical density estimation. A smooth, continuous estimate of reversal rate is obtained using an adaptive kernel method, in which the kernel width is adjusted as a function of reversal rate. The estimates near the ends of the data series (at 165 my ago and the present) are obtained by extending the data by reflection. The results show that the reversal spurts are not associated demonstrably with extinctions or well-dated impacts. If the spurts do record episodes of intense bombardment of the earth, then the mass extinctions do not, in general, occur at times of impacts. Furthermore, the large impact craters seen are not obviously related to the spurts, suggesting that the craters may have been caused by bolides of a different nature and with a different temporal pattern. However, the most simple explanation seems to be that the spurts do not record comet showers, either because the recording mechanism suggested by Muller and Morris is not effective or because comet showers are not triggered in the ways considered by Hut et al.

48203 (N–89-21287, pp. 115-116) **Impact, and its implications for geology.** Marvin, U.B. Lunar and Planetary Inst., Houston, TX (USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird, UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history: An interdisciplinary conference on impacts, volcanism, and mass mortality*. Available from NTIS, PC A11/MF A01.

The publication of seminal texts on geology and on meteoritics in the 1790s, laid the groundwork for the emergence of each discipline as a modern branch of science. Within the past three decades, impact cratering has become universally accepted as a process that sculptures the surfaces of planets and satellites throughout the solar system. Nevertheless, one finds in-depth discussions of impact processes mainly in books on the Moon or in surveys of the Solar System. The historical source of the separation between meteoritics and geology is easy to identify. It began with Hutton. Meteorite impact is an extraordinary event acting instantaneously from outside the Earth. It violates Hutton's principles, which were enlarged upon and firmly established as fundamental to the geological sciences by Lyell. The split between meteoritics and geology surely would have healed as early as 1892 if the investigations conducted by Gilbert (1843-1918) at the crater in northern Arizona had yielded convincing evidence of meteorite impact. The 1950s and 1960s saw a burgeoning of interest in impact processes. The same period witnessed the so-called revolution in the Earth Sciences, when geologists yielded up the idea of fixed continents and began to view the Earth's lithosphere as a dynamic array of horizontally moving plates. Plate tectonics, however, is fully consistent with the geological concepts inherited from Hutton: the plates slowly split, slide, and suture, driven by forces intrinsic to the globe.

48204 (N–89-21287, pp. 118-119) **Shatter cones: Diagnostic impact signatures.** McHone, J.F.; Dietz, R.S. Lunar and Planetary Inst., Houston, TX (USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird, UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history: An interdisciplinary conference on impacts, volcanism, and mass mortality*. Available from NTIS, PC A11/MF A01.

Uniquely fractured target rocks known as shatter cones are associated with more than one half the world's 120 or so presently known impact structures. Shatter cones are a form of tensile rock failure in which a positive conical plug separates from a negative outer cup or mold and delicate ornaments radiating from an apex are preserved on surfaces of both portions. Although distinct, shatter cones are sometimes confused with other striated geologic features such as ventifacts, stylolites, cone-in-cone, slickensides, and artificial blast plumes. Complete cones or solitary cones are rare, occurrences are usually as swarms in thoroughly fractured rock. Shatter cones may form in a zone where an expanding shock wave propagating through a target decays to form an elastic wave. Near this transition zone, the expanding primary wave may strike a pebble or other inhomogeneity whose contrasting transmission properties produce a scattered secondary wave. Interference between primary and secondary scattered waves produce conical stress fields with axes perpendicular to the plane of an advancing shock front. This model supports mechanism capable of producing such shatter cone properties as orientation, apical clasts, lithic dependence, and shock pressure zonation. Although formational mechanics are still poorly understood, shatter cones have become the simplest geologic field criterion for recognizing astroblemes (ancient terrestrial impact structures).

48205 (N–89-21287, pp. 127) **Astrophysical implications of periodicity.** Muller, R.A. Lunar and Planetary Inst., Houston, TX (USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird, UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history: An interdisciplinary conference on impacts, volcanism, and mass mortality*. Available from NTIS, PC A11/MF A01.

Abstract Only.

Two remarkable discoveries of the last decade have profound implications for astrophysics and for geophysics. These are the discovery by Alvarez et al., that certain mass extinctions are caused by the impact on the earth of a large asteroid or comet, and the discovery by Raup and Sepkoski that such extinctions are periodic, with a cycle time of 26 to 30 million years. The validity of both of these discoveries is assumed and the implications are examined. Most of the phenomena described depend not on periodicity, but just on the weaker assumption that the impacts on the earth take place primarily in showers. Proposed explanations for the periodicity include galactic oscillations, the Planet X model, and the possibility of Nemesis, a solar companion star. These hypotheses are critically examined. Results of the search for the solar companion are reported. The Deccan flood basalts of India have been proposed as the impact site for the Cretaceous impact, but this hypotheisis is in contradiction with the conclusion of Courtillot et al., that the magma flow began during a period of normal magnetic field. A possible resolution of this contradiction is proposed.

48206 (N–89-21287, pp. 156-157) **Search for the Tunguska event in the Antarctic snow.** Rocchia, R.; Deangelis, M.; Doclet, D.; Bonte, PH.; Jehanno, C.; Robin, E. Lunar and Planetary Inst., Houston, TX (USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird,

UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history: An interdisciplinary conference on impacts, volcanism, and mass mortality.* Available from NTIS, PC A11/MF A01.

The Tunguska explosion in 1908 is supposed to have been produced by the impact of a small celestial body. The absence of any identifiable crater together with the huge energy released by the event suggest that the impactor exploded in midair and that its material was widely spread over the Earth. The short term contribution of such exceptional events to the total accretion rate of extraterrestrial material by the Earth could be significant. Samples were chosen in a core electromechanically drilled in 1984 near South Pole Station. There, the low temperatures, preventing melting all year long, and the nearly regular snow fall rate provide good conditions for a reliable continuous record of any infalling material. In many samples Ir was below the detection limit of the instrumentation. The iridium infall averaged over 45 samples is given. In a few samples the iridium content is significantly higher than the average: the frequency and amplitude of such fluctuations can be explained by the presence on some filters of finite size cosmic particles. No significant systematic increase above the average level is observed in the part of the core corresponding to the Tunguska event. The two major results of this study are: (1) The presence of Tunguska explosion debris in the Antarctic snow is not confirmed; and (2) The estimate of the average iridium infall, is an order of magnitude lower than the Ganapathy's background but is close to the values measured in Antarctic snow and atmospheric samples by Takahashi et al. The results are also consistent with the flux of micrometeoroids deduced from optical and radar observations or derived from the study of Greenland cosmic dust collection but are lower than the flux at mid-latitude measured in paleocene-oligocene sediments from the central part of the Pacific Ocean.

48207 (N–89-21287, pp. 168-169) **Non-random cratering flux in recent time.** Schultz, P.H. Lunar and Planetary Inst., Houston, TX (USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird, UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history: An interdisciplinary conference on impacts, volcanism, and mass mortality.* Available from NTIS, PC A11/MF A01.

Proposed periodic cycles of mass mortality have been linked to periodic changes in the impact flux on Earth. Such changes in the impact flux, however, also should be recorded on the Moon. Previous studies have concluded that the impact flux on the Moon over the last 1 to 2 billion years has been reasonably constant, but sudden changes in the impact flux over time intervals as short as 30 my could not be detected in these studies unless the added crater population greatly exceeded the cumulative cratering record. Consequently this study focuses only on bright-rayed craters larger than 1 km thereby not only limiting the study to recent craters but also largely eliminating contamination by secondary craters. Preservation of ray patterns and other fine-scale surface textures in the ejecta provides first-order culling of craters younger than Tycho, i.e., about 100 my. Although a periodic change in the impact flux in the Earth-Moon system cannot yet be confirmed from the data, a non-random component appears to exist with an increased flux around 7 and 15 my. The concentrations in different quadrants of the lunar hemisphere would be consistent with a shower of debris generally smaller than 0.5 km.

48208 (N–89-21287, pp. 174-176) **Asteroid and comet flux in the neighborhood of the earth.** Shoemaker, E.M.; Shoemaker, C.S.; Wolfe, R.F. Lunar and Planetary Inst., Houston, TX (USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird, UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history: An interdisciplinary conference on impacts, volcanism, and mass mortality.* Available from NTIS, PC A11/MF A01.

Significant advances in the knowledge and understanding of the flux of large solid objects in the neighborhood of Earth have occurred. The best estimates of the collision rates with Earth of asteroids and comets and the corresponding production of impact craters are presented. Approximately 80 Earth-crossing asteroids were discovered through May 1988. Among 42 new Earth-crossing asteroids found in the last decade, two-thirds were discovered from observations at Palomar Observatory and 15 were discovered or independently detected in dedicated surveys with the Palomar Observatory and 15 were discovered or independently detected in dedicated surveys with the Palomar 46 cm Schmidt. Probabilities of collision with Earth have been calculated for about two-thirds of the known Earth-crossing asteroids. When multiplied by the estimated population of Earth-crossers, this yields an estimated present rate of collision about 65 pct higher than that previously reported. Spectrophotometric data obtained chiefly in the last decade show that the large majority of obvserved Earth-crossers are similar to asteroids found in the inner part of the main belt. The number of discovered Earth-crossing comets is more than 4 times greater than the number of known Earth-crossing asteroids, but reliable data on the sizes of comet nuclei are sparse. The flux of comets almost certainly was highly variable over late geologic time, owing to the random perturbation of the Oort comet cloud by stars in the solar neighborhood.

48209 (N–89-21287, pp. 200-201) **3-dimensional numerical simulation of the atmospheric injection of aerosols by a hypothetical basaltic fissure eruption.** Tripoli, G.J.; Thompson, S.L. Lunar and Planetary Inst., Houston, TX (USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird, UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history: An interdisciplinary conference on impacts, volcanism, and mass mortality.* Available from NTIS, PC A11/MF A01.

Researchers simulated the atmospheric response to a hypothetical basaltic fissure eruption using heating rates based on the Roza flow eruption. The simulation employs the Colorado State University Regional Atmospheric Model (RAMS) with scavenging effects. The numerical model is a three-dimensional non-hydrostatic time-split compressible cloud/mesoscale model. Explicit microphysics include prediction of cloud, rain, crystal, and hail precipitation types. Nucleation and phoretic scavenging are predicted assuming that the pollutant makes an effective cloud droplet nucleus. Smoke is carried as a passive tracer. Long and short wave radiation heating tendencies, including the effects of the smoke, are parameterized. The longwave emission by the lava surface is neglected in the parameterization and included as an explicit heating term instead. A regional scale domain of 100 x 100 km in the horizontal and 22 km high is used. The horizontal grid spacing is taken to be 2 km and the vertical spacing is taken to be 0.75 km. The initial atmospheric state is taken to be horizontally homogenous and based on the standard atmospheric sounding. The fissure is assumed to be 90 km long and oriented in a zig/zag pattern.

48210 (N–89-21287, pp. 202-203) **Causes for geographical variations in OS187/OS186 at the Cretaceous-Tertiary boundary.** Turekian, K.K.; Esser, B.K.; Ravizza, G.E. Lunar and Planetary Inst., Houston, TX (USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird, UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history: An interdisciplinary conference on impacts, volcanism, and mass mortality.* Available from NTIS, PC A11/MF A01.

Abstract Only.

Researchers at Yale have approached the problem of the osmium isotopic composition of marine deposits formed in contact with both oxidized and reduced bottom waters. The measured (187) Os/(186) Os ratios of modern bulk sediment can be explained using mixing equations involving continental detrital, volcaniclastic, cosmogenic and hydrogeneous components. These studies show that sediments deposited under reducing marine conditions contain a hydrogenous component which is enriched in Re and has a radiogenic (187) Os/(186) Os ratio. The presence of such a hydrogenous component in the marine fish clay at Stevns Klint can account for the elevation of its (187) Os/(186) Os ration above the expected meteoritic value. Mass balance considerations require the Re/Os ratio of the phase precipitated from the terminal Cretaceous sea at Stevns Klint to have been about one tenth the value observed in contemporary deposits in the Black Sea, assuming Re has not been lost (or Os gained) subsequent to precipitation. In continental sections, the elevation of the (187) Os/(186) Os ratio in boundary layers may be due to precipitation from continental waters of crustally-derived radiogenic osmium either contemporaneous with the meteoritic (or mantle) osmium deposition or later during diagenesis.

48211 (N–89-21287, pp. 204-205) **Atmospheric erosion by impacts: An analytic investigation.** Vickery, A.M.; Melosh, H.J. Lunar and Planetary Inst., Houston, TX (USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird, UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history: An interdisciplinary conference on impacts, volcanism, and mass mortality.* Available from NTIS, PC A11/MF A01.

Until recently, models for the origin and evolution of the atmospheres of terrestrial planets ignored the effects of accretionary impacts. In the 1970's, however, it was suggested that heating and/or vaporization of accreting carbonaceous-chondrite-type planetesimals could result in the release of their volatile components. Modeling of this process strongly suggests that substantial atmospheres/hydrospheres could develop this way. During most of the accretionary process, impact velocities generally differed little from the escape velocity of the growing proto-planet because most of the collisions were between bodies in nearly matching orbits. Toward the end of accretion, however, collisions were rarer but much more energetic, involving large planetesimals and higher impact velocities. It has been postulated that such impacts result in a net loss of atmosphere from a planet, and that the cumulative effect impacts during the period of heavy bombardment might have dramatically depleted the original atmospheres.

48212 (N–89-21287, pp. 208) **Tektites: Origin as melts produced by the impact of small projectiles onto dry targets.** Wasson, J.T. Lunar and Planetary Inst., Houston, TX (USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird, UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history: An interdisciplinary conference on impacts, volcanism, and mass mortality.* Available from NTIS, PC A11/MF A01.

Abstract Only.

The formation of tektites in general and layered tektites in particular seems to require a very special kind of cratering event. Evidence for the formation of pools of melt free of unmelted clasts has not been reported for the well-studied terrestrial craters such as Manicouagan or Ries. It is suggested that large amounts of relict-free melt were produced only when a sizeable fraction of the cratered target consisted of dry, high-porosity materials such as aeolian sediments. Since dry, high-porosity target materials are always confined to the outer 100 to 200 m of the Earth, the fraction of melt produced melt is probably higher in small (radius 50 to 500 m) craters than in large (r greater than 1 km) craters. Another reason to infer that the Southeast Asian tektites were produced in a multitude of small craters is the wide distribution of layered tektites. The file spans at least 1200 km, which would require ballistic ejection at velocities greater than 2 km s(-1) if all melt was generated in a single crater. It seems impossible to devise a scenario that would lead to the deposition of primary melt as a crystal-free pool at a distance of 600 km from the crater.

48213 (N–89-21287, pp. 213-214) **Disruption of giant comets in the solar system and around other stars.** Whitmire, D.P.; Matese, J.J. Lunar and Planetary Inst., Houston, TX (USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird, UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history: An interdisciplinary conference on impacts, volcanism, and mass mortality.* Available from NTIS, PC A11/MF A01.

In a standard cometary mass distribution (dN/dM) alpha M(-a), a = 1.5 to 2.0 most of the mass resides in the largest comets. The maximum mass M sub max for which this distribution holds uncertain but there are theoretical and observational indications that M sub max is at least approx. 10(23)g. Chiron, although formally classified as an asteroid, is most likely a giant comet in this mass range. Its present orbit is unstable and it is expected to evolve into a more typical short period comet orbit on a timescale of approx. 10(6) to 10(7)yr. The breakup of a chiron-like comet of mass approx. 10(23)g could in principle produce approx. 10(5) Halley-size comets, or a distribution with an even larger number. If a giant comet was in a typical short period comet orbit, such a breakup could result in a relatively brief comet shower (duration approx. less than 10(6)yr) with some associated terrestrial impacts. However, the most significant climatic effects may not in general be due to the impacts themselves but to the greatly enhanced zodiacal dust cloud in the inner Solar System. (Although this is probably not the case for the unique K-T impact). Researchers used a least Chi square program with error analysis to confirm that the 2 to 5 micrometer excess spectrum of Giclas 29 to 38 can be adequately fitted with either a disk of small inefficient (or efficient) grains or a single temperature black body. Further monitoring of this star may allow discrimination between these two models.

48214 (N–89-21287, pp. 215-216) **Collisions with ice-volatile objects: Geological implications.** Wilde, P.; Quinby-Hunt, M.S.; Berry, W.B.N. Lunar and Planetary Inst., Houston, TX (USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird, UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history: An interdisciplinary conference on impacts, volcanism, and mass mortality.* Available from NTIS, PC A11/MF A01.

The collision of the Earth with extra-terrestrial ice-volatile bodies is proposed as a mechanism to produce rapid changes in the geologic record. These bodies would be analogs of the ice satellites found for the Jovian planets and suspected for comets and certain low density bodies in the Asteroid belt. Five generic end-members are postulated: (1) water ice; (2) dry ice: carbon-carbon dioxide rich, (3) oceanic (chloride) ice; (4) sulfur-rich ice; (5) ammonia hydrate-rich ice; and (6) clathrate: methane-rich ice. Due to the volatile nature of these bodies, evidence for their impact with the Earth would be subtle and probably best reflected geochemically or in the fossil record. Actual boloids impacting the Earth may have a variable composition, generally some admixture with water ice. However for discussion purposes, only the effects of a dominant component will be treated. The general geological effects of such collisions, as a function of the dominant component would be: (1) rapid sea level rise unrelated to deglaciation, (2) decreased oceanic pH and rapid climatic warming or deglaciation; (3) increased paleosalinities; (4) increased acid rain; (5) increased oceanic pH and rapid carbonate deposition; and (6) rapid climatic warming or deglaciation.

48215 (N–89-21287, pp. 225-226) **New approach to the origin of the tektite in China.** Qin-Wen, ZHANG; Dao-yi, XU; Zheng, YAN. Lunar and Planetary Inst., Houston, TX (USA). 1988. (NASA-CR–183329;NAS–1.26:183329;LPI-CONTRIB–673;CONF-8810341–: Global catastrophes conference, Snowbird, UT (USA), 20-23 Oct 1988). In *Global catastrophes in earth history: An interdisciplinary conference on impacts, volcanism, and mass mortality.* Available from NTIS, PC A11/MF A01.

The tektites in China are distributed on the north part of Australia - Southeastern Asia strewfield of tektite: Leizhou Peninsula of Guangdong Province and Hainan Island, and located exactly at the boundary between Zanjiang Formation and Beihai Formation. A new hypothesis is suggested: During the end of Lower Pleistocene, a comet of special components from the outer part of the Solar System approached the Earth, and then it was captured by the Earth, when it came approximately to the Roche's limit. It was crushed into countless fragments, detritus and dusts, which rotated around the Earth, probably far above the Earth's atmosphere, as a cloud ring. Under the action of crushing energy they could be in the situation of liquid-melt drop in the almost vacuum circumstances and the flow and bubble structure were formed. During their rotation the climate became anomalous and the violet Fe-Si concentration were formed on the surface of sediments. After a rather short time of rotation the unstable ring was broken and the fragments impacted on the hard ground instantaneously.

48216 (N–89-21635) **Positron line radiation from halo WIMP annihilations as a dark matter signature.** Turner, M.S.; Wilczek, F. Fermi National Accelerator Lab., Batavia, IL (USA). Feb 1989. 12p. (NASA-CR–182918;NAS–1.26:182918;FERMILAB-PUB–89/44-A). Available from NTIS, PC A03/MF A01.

We suggest a new signature for dark matter annihilation in the halo: high energy positron line radiation. Because the cosmic ray positron spectrum falls rapidly with energy, e+'s from halo WIMP annihilations can be a significant, clean signal for very massive WIMP's (approx. greater than 30 GeV). In the case that the e+e- annihilation channel has an appreciable branch, the e+ signal should be above background in a future detector, such as have been proposed for ASTROMAG, and of potential importance as a

dark matter signature. A significant e+e- branching ratio can occur for neutralinos or Dirac neutrinos. High-energy, continuum positron radiation may also be an important signature for massive neutralino annihilations, especially near or above the threshold of the W+W- and ZoZo annihilation channels.

48217 (N–89-21712) **NASA Marshall Space Flight Center solar observatory report, January-December 1987.** Smith, J.E. National Aeronautics and Space Administration, Huntsville, AL (USA). George C. Marshall Space Flight Center. Mar 1989. 74p. (NASA-TM–100360;NAS–1.15:100360). Available from NTIS, PC A04/MF A01.

This report provides a description of the NASA Marshall Space Flight Center's Solar Vector Magnetograph Facility and gives a summary of its observations and data reduction during January to December 1987. The systems that make up the facility are a magnetograph telescope, an H-alpha telescope, a Questar telescope, and a computer code. The data are represented by longitudinal contours with azimuth plots.

48218 (N–89-21716) **Evolution of cosmic string networks.** Albrecht, A.; Turok, N. Fermi National Accelerator Lab., Batavia, IL (USA). Mar 1989. 80p. (NASA-CR–182836;NAS–1.26:182836;FERMILAB-PUB–89/42-A;PUPT–89-1119). Available from NTIS, PC A05/MF A01.

A discussion of the evolution and observable consequences of a network of cosmic strings is given. A simple model for the evolution of the string network is presented, and related to the statistical mechanics of string networks. The model predicts the long string density throughout the history of the universe from a single parameter, which researchers calculate in radiation era simulations. The statistical mechanics arguments indicate a particular thermal form for the spectrum of loops chopped off the network. Detailed numerical simulations of string networks in expanding backgrounds are performed to test the model. Consequences for large scale structure, the microwave and gravity wave backgrounds, nucleosynthesis and gravitational lensing are calculated.

48219 (PB–89-173041/XAB) **Solar-Geophysical Data Number 534, February 1989. Part 1 (prompt reports). Data for January 1989, December 1988, and late data.** Coffey, H.E. National Geophysical Data Center, Boulder, CO (USA). Feb 1989. 172p. (SGD–534-PT-1). Available from NTIS, PC A08/MF A01.

See also Part 2, PB–89-173058 and PB–89-130835.

Contents include: detailed index for 1988-1989; data for January 1989 (IUWDS alert periods (advance and worldwide), solar-activity indices, solar flares, solar radio emission, stanford mean solar magnetic field); data for December 1988 (solar-active regions, sudden ionospheric disturbances, solar radio-spectral observations, cosmic-ray measurements by neutron monitor, geomagnetic indices, radio propagation indices); late data (solar radio emission, cosmic-ray measurements by neutron monitor (errata), geomagnetic indices).

48220 (PB–89-185300/XAB) **Application of the generalized newton-raphson method to the singly-ionized calcium line formation problem in model stellar atmospheres. Doctoral thesis.** Domenico, B.A. National Center for Atmospheric Research, Boulder, CO (USA). 1972. 115p. (NCAR/CT–25). Available from NTIS, PC A06/MF A01.

A new method is proposed for solving the statistical equilibrium and radiative-transfer equations for the level populations of a multilevel model atom in a model stellar atmosphere. These two sets of equations are reduced to a single system of nonlinear operator equations by incorporating the integral form of the radiative transfer equations into the equations of statistical equilibrium. An iterative procedure for solving the system based on the Generalized Newton-Raphson (GNR) method is described and compared to other methods currently being used to solve such problems. The GNR method eliminated the possibility of convergence to inconsistent solutions and, in certain test cases, reduced the number of iterations necessary to reach convergence by as much as an order of magnitude.

48221 (PB–89-185987/XAB) **Solar-Geophysical Data Number 535, March 1989. Part 1 (prompt reports). Data for February, January 1989, and late data.** Coffey, H.E. National Geophysical Data Center, Boulder, CO (USA). Mar 1989. 143p. (SGD–535-PT-1). Available from NTIS, PC A07/MF A01.

See also Part 2, PB–89-185995, and PB–89-139943.

Contentsinclude: detailed index for 1988-1989; data for february 1989 (IUWDS alert periods (advance and worldwide), solar-activity indices, solar flares, solar radio emission, Stanford mean solar magnetic field); data for January 1989 (solar active regions, sudden ionospheric disturbances, solar radio spectral observations, cosmic-ray measurements by neutron monitor, geomagnetic indices, radio-propagation indices); late data (solar-active regions– H-alpha synoptic charts 1806-1808 (September-November 1988), cosmic-ray measurements by neutron monitor–thule, December 1988, geomagnetic indices – sudden commencements/solar flare effects December 1988).

48222 (PB–89-185995/XAB) **Solar-Geophysical Data Number 535, March 1989. Part 2 (comprehensive reports). Data for September 1988, and miscellaneous.** Coffey, H.E. National Geophysical Data Center, Boulder, CO (USA). Mar 1989. 77p. (SGD–535-PT-2). Available from NTIS, PC A05/MF A01.

See also Part 1, PB–89-185987.

Contents include: detailed index for 1988 and 1989; data for September 1988 (solar flares, solar radio bursts at fixed frequencies, solar x-ray radiation from GOES satellite, mass ejections from the sun, active prominences and filaments); miscellaneous data – interplanetary solar wind data, IMP-8, February-November 1988.

48223 (RRK–89-10) **Gravitational lens effect on the cosmic background radiation due to nonlinear inhomogeneities.** Tomita, Kenji; Watanabe, Kazuya. Hiroshima Univ., Takehara (Japan). Research Inst. for Theoretical Physics. Apr 1989. 25p. Order Number DE90701753/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

Null geodesic equations are numerically solved, in order to investigate the light propagation in inhomogeneous cosmological models. The models are derived using the N body simulation method and assuming for simplicity that clusters of galaxies are regarded as particles. Statistical properties of angular fluctuations of light paths and angular correlation fuctions of the cosmic background radiation are studied. It is shown that the angular fluctuation due to gravitational lensing depend much on the particle size. If it is equal to the size of the Coma cluster, the lens effect is so large to decrease the finite-beam-smeared temperature fluctuations of the cosmic backgound radiation by a factor $\geq$2, compared with those in the no-lens case, while the non-smeared temperature fluctuations are much enhanced for angles $\geq$0.5 arcmin. (author).

48224 (SER-C-PREPUBL-FASC–29) **Grids of evolutionary models from 0.85 to 120 solar masses: Observational tests and the mass limits.** Maeder, A.; Meynet, G. Geneva Observatory (Switzerland). 1988. 33p. (ETN–89-93745). Available from NTIS, PC A03/MF A01.

Grids of stellar evolutionary models with composition X=0.70, Z=0.02 are computed with mass loss and moderate core overshooting. Comparisons between models and cluster observations are performed for low and intermediate mass stars in order to determine the amount of core overshooting. The comparisons cover: (1) the main sequence width of intermediate and old open star clusters, (2) the blue extension of the loops described in the HR diagram during the He-burning phase, (3) the number ratio of blue to red giants in the He-phase, (4) the luminosity difference between the yellow giants and the MS turnoff, and (5) the upper mass limit for degenerate He-burning. In agreement with the results for high mass stars, the tests clearly suggest moderate overshooting from convective cores with a distance of overshooting =0.25 H sub P, rather than in favor of no or of large overshooting. The consequence of this moderate overshooting on several stellar mass limits is substantial, but not drastic. The models also suggest that the consequences of overshooting in pre-MS evolution could be important for the further evolution of solar mass stars.

48225 (SER-C-PREPUBL-FASC–30) **Tables of evolutionary star models from 0.85 to 120 solar masses with overshooting and mass loss.** Maeder, A.; Meynet, G. Geneva Observatory (Switzerland). 1988. 16p. (ETN–89-93746). Available from NTIS, PC A03/MF A01.

The tables of evolutionary star models for Pop 1 composition in the 0.85 to 120 solar mass range with overshooting and mass loss are presented. Most of the tracks are described by 40 points, at well chosen corresponding evolutionary stages in order to allow the computation of accurate isochrones.

48226 (SER-C-PREPUBL-FASC–32) **Upper main sequence of OB associations. 1: Spectral types and lines of C and N of southern single-lined O stars.** Mathys, G. Geneva Observatory (Switzerland). 1988. 20p. (ETN–89-93748). Available from NTIS, PC A03/MF A01.

The properties of the stars on the upper main sequence of OB associations are studied in order to provide constraints on evolutionary models. The single-lined O stars belonging to the southern associations Vel OB1, Car OB1, Cen OB1 and Sco OB1 are considered. Spectral type is derived in Conti's classification scheme for O stars, amended to include the O9.7 subtype and to deal with fairly high S/N CCD spectra (compared with the original photographic material for which the classification methodology was devised). The behavior of the C and N lines of these stars is examined to determine whether CNO-processed material is visible at their surface. Stars in which the observed behavior of the C and N lines indicates that CNO-processed elements may be seen at the surface are presented.

48227 (UCRL–101436) **High pressure studies of planetary matter.** Ross, M. Lawrence Livermore National Lab., CA (USA). Jun 1989. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890798–11: AIRAPT and EHPRG international high pressure science and technology conference, Paderborn (Germany, F.R.), 17-21 Jul 1989). Order Number DE89017738/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Those materials which are of greatest interest to the physics of the deep planetary interiors are Fe, H_2, He and the Ices. These are sufficiently diverse and intensively studied to offer an overview of present day high pressure research. 13 refs., 1 fig.

48228 (UCRL–101753) **Properties of strongly coupled multi-ionic plasmas.** DeWitt, H.E.; Slattery, W.L.; Stringfellow, G.S. Lawrence Livermore National Lab., CA (USA). Aug 1989. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8908133–2: 24. Yamada conference on strongly coupled plasma physics, Tokyo (Japan), 29 Aug - 2 sep 1989). Order Number DE89017782/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A reexamination of the OCP fluid equation of state using new Monte Carlo results gives the EOS as $-(9/10)\,\Gamma + b\Gamma^{s}$ with $s \sim 1/3$ rather than the 1/4 value obtained previously. The EOS for the bcc crystalline phase indicates that first order anharmonic corrections are present. A recalculation of the freezing transition leaves the bcc transition unchanged at about $\Gamma = 178$, but the transition to fcc is lower, about 192. For ionic mixtures the HNC equations were solved and give a nearly perfect agreement with the linear mixing rule. 23 refs., 1 fig., 5 tabs.

48229 **Dynamics of superclusters - reconciling Omega(0) = 1.0 with observations?.** Hoffman, Yehuda (Los Alamos National Lab., NM (USA)). *Astrophysical Journal (USA),* 340: 69-76 (May 1989).

The dynamics of superclusters is investigated within the Zel'dovich quasi-linear approximation. The density and infall velocity field of a supercluster are calculated to quasi-linear order and then are used as input parameters to the standard model to yield an apparent value of Omega. An ensemble of superclusters seeded by the local maxima of a Gaussian delta field is constructed to yield a distribution of Omega(app) values. The resulting value of Omega(app) of a given supercluster depends on its stage of dynamical evolution and the magnitude of the shear component. Application of these calculations to the Local Supercluster shows that, where the density is measured in reshift space, an observed value of Omega of about 0.2 is consistent with an actual Omega(0) = 1.0. 57 refs.

48230 **Gamma-ray burster counterparts - Radio.** Schaefer, B.E. (Maryland Univ., College Park (USA)); Cline, T.L.; Desai, U.D.; Teegarden, B.J.; Atteia, J.L.; Barat, C.; Estulin, I.V.; Evans, W.D.; Fenimore, E.E.; Hurley, K. *Astrophysical Journal (USA),* 340: 455-457 (May 1989).

Many observers and theorists have suggested that gamma-ray bursters (GRBs) are related to highly magnetized rotating, neutron stars, in which case an analogy with pulsars implies that GRBs would be prodigious emitters of polarized radio emission during quiescence. The paper reports on a survey conducted with the Very Large Array radio telescope of 10 small GRB error regions for quiescent radio emission at wavelengths of 2, 6, and 20 cm. The sensitivity of the survey varied from 0.1 to 0.8 mJy. The observations did indeed reveal four radio sources inside the GRB error regions. 27 refs.

48231 **High-speed optical photometry of the DQ Herculis object H2215-086.** Steiman-Cameron, T.Y. (NASA, Ames Research Center, Moffett Field, CA (USA)); Steiman-Cameron, D.V.; Imamura, J.N. *Astrophysical Journal (USA),* 339: 434-442 (Apr 1989).

The paper presents the results of high-time-resolution white-light photometry of H2215-086 obtained at Las Campanas Observatory and Cerro Tololo Inter-American Observatory during 1985-1987. Descriptions of periodic features, including power spectra due to rotational and orbital modulation, are presented as well as quasi-periodic features. It is found that H2215-086 displays large-amplitude modulations in its optical, IR, and X-ray emission on the 20.9 min rotational period of the white dwarf. Possible sites for this emission are discussed. 31 refs.

6402 Atmospheric Physics

Refer also to citation(s) 48219, 48221, 48583

48232 (AD-A–205543/2/XAB) **Ionospheric scintillations/TEC and in-situ density measurements at an auroral location in the European sector. Environmental research papers, 2 October 1986-31 July 1987.** MacKenzie, E.; Basu, S. Air Force Geophysics Lab., Hanscom AFB, MA (USA). 14 Aug 1987. 43p. (AFGL-TR–87-0245). Available from NTIS, PC A03/MF A01.

The orbiting HiLat satellite launched in 1983 offered an opportunity for studying ionospheric scintillation parameters in relation to in-situ measurements of ionization density, drift velocity, field-aligned current, and particle precipitation during the sunspot-minimum period. This report discusses results of a morphological study based on observations of scintillations and total electron content (TEC) at the auroral-oval station at Tromso, Norway, during the period Dec 1983 - Oct 1985. The geometrical enhancement of scintillations observed during alignment of the propagation with the local magnetic L-shell is shown to be the most consistent and conspicuous feature of scintillations in the nighttime auroral oval. The dynamics of the spatial and temporal extent of this region are illustrated in the invariant latitude/magnetic local time grid. Steepening of phase spectral slope in the geometrical enhancement region is indicative of the presence of L-shell aligned sheet-like irregularities at long scale lengths. The seasonal variation of TEC determined from the differential Doppler measurements of HiLat transmissions is discussed in relation to the in-situ density measurements at 830 km. The results are also used to illustrate the dependence of ionospheric structure parameters on short-term variability of solar activity during the sunspot-minimum period. This study provides an insight into the nature of magnetospheric coupling with the ionosphere at high latitudes.

48233 (AD-A–205704/0/XAB) **Origin of density enhancements in the winter polar-cap ionosphere.** Anderson, D.N.; Buchau, J.; Heelis, R.A. Air Force Geophysics Lab., Hanscom AFB, MA (USA). 7 May 1987. 11p. (AFGL-TR–88-0251). Available from NTIS, PC A03/MF A01.

Pub. in The Effect of the Ionosphere on Communication, Navigation, and Surveillance Systems Based on Ionospheric Effects Symposium, 619-657(5-7 May 1987).

Coherent and incoherent ground-based radar measurements of the winter polar cap ionosphere at Thule and Sondrestrom, Greenland, have established the existence of patches of enhanced ionization that drift across the polar cap in an antisunward, noon-midnight direction. Associated with these patches is strong radio scintillation activity which severely disrupts ground-to-satellite communication systems and interferes with the operation of space

surveillance radar at high latitudes. Several recent studies have shown that the source of enhanced ionization is the sunlit sub-cusp ionosphere rather than production by precipitating energetic particles. This problem is studied by solving the time-dependent plasma continuity equation including production by solar ultraviolet radiation, loss through charge exchange and transport by diffusion and convection E X B drifts. Time and spatially varying, horizontal E X B drift patterns are imposed and subsequent ionospheric responses are calculated to determine enhanced plasma densities. In the dark polar cap could result from extended transit of relevant flux tubes through regions of significant solar production. A density enhancement in NMAX from 70,000 to 500,000 el/cu cm occurs at Thule when a time-varying convection pattern is included in the simulation. The patch of ionization is generated when an initial convection pattern characterized by an 80-kV crosstail potential and a 12° polar cap radius is abruptly changed to a 100-kV crosstail potential and a 15° polar-cap radius. The horizontal extent of the patch is related to the length of time the new convection pattern remains turned-on.

48234 (AD-A-206457/4/XAB) **Estimation of ionospheric electrodynamic parameters using ionospheric conductance deduced from bremsstrahlung x-ray image data. Technical report.** Ahn, B.; Kroehl, H.W.; Kamide, Y.; Gorney, D.J. Aerospace Corp., El Segundo, CA (USA). Space Sciences Lab. 16 Feb 1989. 56p. (TR-0088(3940-06)-4). Available from NTIS, PC A04/MF A01.

Various ionospheric electrodynamic parameters are calculated by using ground magnetic records from a total of 88 stations in the northern hemisphere. For this purpose, an instantaneous conductance distribution deduced from the DMSP-F6 bremsstrahlung X-ray image data is utilized. It is a unique opportunity to examine some of the inherent ambiguity in the magnetogram-inversion technique based on a statistically-derived conductance model. Important conclusions are: (1) The pole-ward portion of the westward electrojet in the morning sector is dominated by electric field, while its equatorward portion is dominated by the ionospheric conductance. (2) During a quiet or moderately disturbed period, the major electric potential pattern is roughly circumscribed by the auroral zone conductance belt. (3) The global pattern of the equivalent current system resembles the electrical potential distribution. (4) The electric potential distribution consists generally of a smooth and well-defined two-cell convection pattern without any significantly localized structure. (5) A sunward convection flow is clearly identified over the polar-cap region. (6) During strongly northward IMF periods, significant currents and joule dissipation are observed in the polar cap-region, indicating that the magnetosphere is far from its ground state. (7) The regions of intense joule heating are generally confined to relatively narrow belts. (8) The Region 2 upward current in the morning hemisphere is roughly collocated with the enhanced conductance region. (9) The presently available statistical conductance models can be used, as a first approximation, to study global-scale polar ionospheric electrodynamics.

48235 (AD-A-207396/3/XAB) **Nonlinear model of wave-particle interactions in the trapped radiation belts: Auroral-pulsation solutions.** Davidson, G.T.; Chiu, Y.T. Lockheed Missiles and Space Co., Palo Alto, CA (USA). Lockheed Palo Alto Research Lab. Nov 1987. 11p. Available from NTIS, PC A03/MF A01.

Pub. in Geophysical Research Letters, Vol. 14, No. 11, 1166-1169(Nov 1987).

The interactions of waves and trapped electrons are described by a closed system of three nonlinear coupled equations. The model has applications to many aspects of wave-particle interactions in the magnetosphere. Nonlinear numerical solutions pertinent to auroral pulsations have been computed for realistic ranges of physical parameters. The results confirm that precipitation pulsations can be initiated by either an injection of energetic trapped particles or an increase in the plasma ionization density. Relaxation of the system results in cyclic phase trajectories about a (quasi-equilibrium) point that is not located at the initial equilibrium point. That observation may explain the tendency of auroral pulsations to appear superimposed upon an increase in the general rate of electron precipitation. The results also imply that precipitation pulsations are most readily initiated by an encounter of drifting energetic electrons with a region of enhanced cold plasma density.

48236 (AD-A-207416/9/XAB) **Multipoint measurements from substorm onset to recovery: The relation between magnetic pulsations and plasma-sheet thickening.** Singer, H.J.; Hones, E.W.; Rosenberg, T.J. Air Force Geophysics Lab., Hanscom AFB, MA (USA). 1988. 5p. (AFGL-TR-89-0113). Available from NTIS, PC A02/MF A01.

Pub. in Adv. Space Res., Vol. 8, No. 9-10, (9)443-(9)446(1988).

Long-duration waves in the Pi2 frequency band (6.7 - 22 mHz) were observed by the Air Force Geophysics Laboratory (AFGL) Magnetometer Network during a set of substorms previously analyzed. For these events that on the order of 1 hour after the expansive phase onset of a substorm, there was a sudden appearance of riometer absorption observed at South Pole Station (magnetic latitude about -75 deg) and a reappearance of the plasma sheet as observed in 6-keV electrons by ISEE 1 and 2 satellites at a distance of 15 to 20 R(sub e) in the magnetotail. The wave activity observed at the AFGL stations during these events diminished significantly at approximately the time of the plasma sheet recovery or riometer increase. One explanation for the long duration of these waves is that following substorm onset, they are continuously generated in a near-tail reconnection region and then decay when the neutral line moves tailward during the substorm recovery phase.

48237 (AD-A-207547/1/XAB) **Space particle environment. Technical report.** Vampola, A.L. Aerospace Corp., El Segundo, CA (USA). Space Sciences Lab. 28 Mar 1989. 32p. (TR-0088(3940-05)-8). Available from NTIS, PC A03/MF A01.

This report is a tutorial covering the energetic charged-particle environment in the earth's magnetosphere. It provides an overview of trapped particle morphology, the geometry of the trapping regions, the radiation environmental models, the current status of these models, and future modeling requirements.

48238 (INIS-mf-11537, pp. 28) **Streamer to glow transition in the positive air corona.** Lamb, D.W. (New England Univ., Armidale (Australia). Dept. of Physics); Woolsey, G.A. Australian Inst. of Nuclear Science and Engineering, Lucas Heights (Australia). 1989. (CONF-8902130-: 17. AINSE plasma physics conference, Lucas Heights (Australia), 6-8 Feb 1989). In *17th AINSE plasma physics conference: conference handbook.* Order Number DE90600936/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

Abstract only.

48239 (INIS-SU-113/A, pp. 29-31) **Sensitivity of high-energy muon flux from atmosphere to parameters of hadronic charm production.** Dremin, I.M.; Madigozhin, D.T. AN SSSR, Moscow (USSR). Fizicheskij Inst. 1989. (In Russian). (T-23539). In *Experimental and theoretical physics. Collection.* Order Number DE89018003/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Kratkie soobshcheniya po fizike.; v. 1.

In scaling approximation the angular distribution of high-energy atmospheric muons in calculated, taking into account the contribution of direct muons, produced in fast decays of charm particles and resulting in the distortion of angular distribution, characteristic of conventional, trivial muons, appearing as a result of pion and kaon decays. By the angular distribution of the flaw of high-energy muons from the atmosphere the upper boundary of charm production cross section part of total inelastic cross section in the energy range of 100-300 TeV is determined, being 0.125. 8 refs.; 2 figs.

48240 (LA-UR-89-2529) **Observations of flux transfer events: Are FTEs flux ropes, islands, or surface waves?.** Elphic, R.C. Los Alamos National Lab., NM (USA). 1989. 31p. Sponsored by DOE/DP;NASA. DOE Contract W-7405-ENG-36. (CONF-8903131-3: Chapman conference on the physics of magnetic flux ropes, Hamilton (Bermuda), 27-31 Mar 1989). Order Number DE89015291/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Flux transfer events (FTEs) are widely regarded as a signature of transient magnetic reconnection between the solar wind and magnetospheric plasmas. However, there is disagreement on what form this reconnection takes: Are FTEs tearing islands, or time-varying single x-line reconnection? We reexamine the evidence that first led

to the suggestion that FTEs are related to a non-time-stationary reconnection process. In particular we discuss how the combination of field and plasma variations suggest that FTEs are magnetic flux ropes. Both time-varying single x-line reconnection and multiple x-line merging can produce a signature which 'mimics' that of a flux rope, but without the flux rope topology. Finally, we review the evidence that FTEs cannot be merely surface waves: their occurrence during southward IMF, mixture of solar wind and magnetospheric plasmas, leakage of energetic particles, accelerated plasma flows and peculiarities of the magnetic signature all point to a reconnection-related phenomenon. 38 refs., 16 figs.

48241 (LA-UR–89-2740) **Computer simulations of electromagnetic ion instabilities in the plasma sheet boundary layer.** Gary, S.P.; Winske, D. Los Alamos National Lab., NM (USA). 1989. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-8906201–1: Workshop on theoretical geoplasma physics, Cambridge, MA (USA), Jun 1989). Order Number DE89016596/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Linear Vlasov dispersion theory and one-dimensional hybrid computer simulations are used to study electromagnetic instabilities driven by hot, anisotropic counterstreaming proton components which model those observed from ISEE in the plasma sheet boundary layer of the near-Earth magnetotail. The proton anisotropies lead to the ion cyclotron anisotropy instability, which saturates at a low level of fluctuating fields and yields only weak proton scattering. Modest increases of the proton/proton relative drift, which might correspond to deeper tail conditions, excite the proton/proton nonresistant instability which attains larger fluctuation levels and more strongly heats the protons. If a relatively dense oxygen ion component is also introduced, the ion/ion right-hand resonant instability is excited; the consequent pitch-angle scattering of the protons resembles that indicated in the ISEE data. 6 refs., 5 figs.

48242 (LA-UR–89-2746) **Short wavelength striations on expanding plasma clouds.** Winske, D.; Gary, S.P. Los Alamos National Lab., NM (USA). 1989. 25p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-8906201–2: Workshop on theoretical geoplasma physics, Cambridge, MA (USA), Jun 1989). Order Number DE89016585/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The growth and evolution of short wavelength (<ion gyroradius) flute modes on a plasma expanding across an ambient magnetic field have been actively studied in recent years, both by means of experiments in the laboratory as well as in space and through numerical simulations. We review the relevant observations and simulations results, discuss the instability mechanism and related linear theory, and describe recent work to bring experiments and theory into better agreement. 30 refs., 6 figs.

6403 Atomic, Molecular, and Chemical Physics

Refer also to citation(s) 47452, 47818, 48395, 48426, 48432, 48468, 48494, 48520, 48658, 48743

48243 (AD-A–207216/3/XAB) **Low-energy atomic collisions. Final scientific report, 1 June-30 September 1980.** Neynaber, R.H.; Tang, S.Y. La Jolla Inst., CA (USA). 31 Oct 1980. 5p. Available from NTIS, PC A02/MF A01.

A description of charge-transfer studies of HCl(+) in Xe using a merging-beams technique is given. Absolute and relative cross sections were obtained for collision energies from 0.01 to 870eV. The goal of this experimental program was to study selected chemi-ionization and ion-molecule reactions by merging-beams techniques to better understand the dynamics of such collisions and to provide data to assist in the formulation of theory. The relative energy of the reactants for these studies was varied from threshold to 10 or 20 eV. These studies give a clearer picture of the role played by the kinetic and internal energy of reactants at low relative energies. This is important for the development of advanced Air Force systems that require communication through either a naturally or artificially ionized atmosphere, for the development of propulsion systems for the Air Force, and for advancing the technology of lasers.

48244 (CONF-890708–7) **Synchrotron-radiation experiments with recoil ions.** Levin, J.C. Oak Ridge National Lab., TN (USA). [1989]. 8p. Sponsored by DOE/ER;NSF. DOE Contract AC05-84OR21400. From 16. international conference on the physics of electronic and atomic collisions; New York, NY (USA); 26 Jul - 1 aug 1989. Order Number DE89017579/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Studies of atoms, ions and molecules with synchrotron radiation have generally focused on measurements of properties of the electrons ejected during, or after, the photoionization process. Much can also be learned, however, about the atomic or molecular relaxation process by studies of the residual ions or molecular fragments following inner-shell photoionization. Measurements are reported of mean kinetic energies of highly charged argon, krypton, and xenon recoil ions produced by vacancy cascades following inner-shell photoionization using white and monochromatic synchrotron x radiation. Energies are much lower than for the same charge-state ions produced by charged-particle impact. The results may be applicable to design of future angle-resolved ion-atom collision experiments. Photoion charge distributions are presented and compared with other measurements and calculations. Related experiments with synchrotron-radiation produced recoil ion, including photoionization of stored ions and measurement of shakeoff in near-threshold excitation, are briefly discussed. 24 refs., 6 figs., 1 tab.

48245 (DOE/ER/40256–4) **[Cyclotron based nuclear science]: Progress in research, April 1, 1988–March 31, 1989.** Texas A and M Univ., College Station, TX (USA). Cyclotron Inst. Jun 1989. 170p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-86ER40256. Order Number DE89017357/JAW. Available from NTIS, PC A08/MF A01; OSTI; INIS; GPO Dep.

This report contains papers on the following topics: Heavy ion reactors, nuclear structure and fundamental interactions; atomic and materials studies; nuclear theory; and superconducting cyclotron and instrumentation. (LSP)

48246 (FIAS-R–175) **Spatial non-uniformity in discharges in low pressure helium and neon.** Fletcher, J.; Purdie, P.H. Flinders Univ. of South Australia, Bedford Park (Australia). Inst. for Atomic Studies. Aug 1986. 20p. Order Number DE90600777/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Submitted to Aust. J. Phys.

Low current, low pressure steady state Townsend discharges in neon and helium gas have been investigated using the photon flux technique. Such discharges have been found to exhibit spatial non-uniformity resulting in luminous layers throughout the discharge. The separation and structure of these layers has been investigated experimentally in both gases along with the wavelength distribution of the photon flux. A Monte Carlo simulation of the discharge in neon has been used to gain information on the cross sections necessary to describe these discharges. It is found that direct excitation of ground state atoms to the resonance level of each gas is less than indicated by some published cross section data.

48247 (FIAS-R–177) **Electron scattering from sodium at intermediate energies.** Mitroy, J.; McCarthy, I.E.; Stelbovics, A.T. Flinders Univ. of South Australia, Bedford Park (Australia). Inst. for Atomic Studies. Oct 1986. 51p. Order Number DE90600798/JAW. Available from NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS.

Submitted to J. Phys., B.

A comprehensive comparison is made between theoretical calculations and experimental data for intermediate energy ($\geq$ 10 eV) electron scattering from sodium vapour. The theoretical predictions of coupled-channels calculations (including one, two or four channels) do not agree with experimental values of the differential cross sections for elastic scattering or the resonant 3s to 3p excitation. Increasingly-more-sophisticated calculations, incorporating electron correlations in the target states, and also including core-excited states in the close-coupling expansion, are done at a few selected energies in an attempt to isolate the cause of the discrepancies between theory and experiment. It is found that these more-sophisticated calculations give essentially the same results as the two- and four-channel calculations using Hartree-Fock wavefunctions. Comparison of the sodium high-energy elastic differential cross sections with those of neon suggests that the sodium differential cross section experiments may suffer from systematic errors.

There is also disagreement, at the higher energies, between theoretical values for the scattering parameters and those that are derived from laser-excited superelastic scattering and electron photon coincidence experiments. When allowance is made for the finite acceptance angle of the electron spectrometers used in the experiments by convoluting the theory with a function representing the distribution of electrons entering the electron spectrometer it is found that the magnitudes of the differences between theory and experiment are reduced.

48248 (FIAS-R–178) **Valence electronic structure of CH_3F and CH_3Cl: electron momentum distributions and separation energies.** Minchinton, A.; Cook, J.P.D.; Weigold, E.; Niessen, W. von. Flinders Univ. of South Australia, Bedford Park (Australia). Inst. for Atomic Studies. Oct 1986. 28p. Order Number DE90600778/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Fluoromethane (CH_3F) has been studied by binary (e,2e) coincidence spectroscopy at 1200 eV using non-coplanar symmetric kinematics. Separation energy spectra have been determined in the energy range up to 50 eV at azimuthal angles of 0 degrees and 9 degrees. The separation energy spectra and electron momentum distributions measured for the valence orbitals of CH_3F and CH_3Cl are compared with the results of calculations employing SCF wavefunctions outer valence as well as extended 2ph-TDA Green's function methods. Electron density and momentum density maps have been generated for all valence orbitals of both molecules. using the SCF wavefunctions and are used to explain differences in the bonding properties of the halomethanes investigated here.

48249 (FIAS-R–179) **Orbital momentum distribution and binding energies for the complete valence shell of molecular chlorine by electron momentum spectroscopy.** Frost, L.; Grisogono, A.M.; McCarthy, I.E. and others. Flinders Univ. of South Australia, Bedford Park (Australia). Inst. for Atomic Studies. Oct 1986. 42p. Order Number DE90600779/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Submitted to Chem. Phys.

The complete valence shell binding energy spectrum (10-50 eV) of Cl_2 has been determined using electron momentum (binary (e,2e)) spectroscopy. The inner valence region, corresponding to $4\sigma_u$ and $4\sigma_g$ ionization, has been measured for the first time and shows extensive splitting of the ionization strength due to electron correlation effects. These measurements are compared with the results of many-body calculations using Green's function and CI methods employing unpolarised as well as polarised wave functions. Momentum distributions, measured in both the outer and inner valence regions, are compared with calculations using a range of unpolarised and polarised wave functions. Computed orbital density maps in momentum and position space for oriented Cl_2 molecules are discussed in comparison with the measured and calculated spherically averaged momentum distributions.

48250 (FIAS-R–185) **Statistical regularization applied to the analysis of e-He scattering data.** Allen, L.J.; McCarthy, I.E. Flinders Univ. of South Australia, Bedford Park (Australia). Inst. for Atomic Studies. Apr 1987. 27p. Order Number DE90600799/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Submitted to Phys. Rev., A.

Statistical regularization as applied to phase shift analysis of elastic scattering data and to the construction of potentials from such data is discussed. A recent phase-shift analysis and determination of potentials from e-He scattering data below the first excitation threshold is substantially improved by these techniques. The extraction of total elastic and momentum transfer cross sections from the differential cross section data with a rigorous error analysis is discussed.

48251 (FIAS-R–188) **Electron momentum spectroscopy of molecules: a review of recent developments.** Weigold, E. Flinders Univ. of South Australia, Bedford Park (Australia). Inst. for Atomic Studies. Jul 1987. 27p. (CONF-8707133–: International electron molecule scattering and photoionization meeting, Daresbury (UK), 18-19 Jul 1987). Order Number DE90600800/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Invited lecture.

Conventional spectroscopic studies of atoms and molecules have for the most part concentrated on the determination of the energy level structure. Electron momentum spectroscopy, also formerly known as binary (e,2e) spectroscopy, has added a crucial further dimension of information, namely the determination of the momentum distributions for the electrons associated with the separate valence orbitals. Since its inception over a decade ago, it has developed into a technique which is providing increasingly sensitive tests of state-of-the-art theoretical quantum chemical calculations. Measured orbital momentum distributions (more exactly the squares of the momentum space ion-neutral overlaps) have provided very sensitive tests of calculated orbital wavefunctions or ion-neutral overlaps. In an EMS experiment the kinematics of the noncoplanar symmetric reaction is completely determined. Studies of some atoms, notably the argon ion, and of a number of molecules including the halomethanes are reviewed. 26 refs., 13 figs.

48252 (FIAS-R–189) **Orbital momentum distribution and binding energies for the complete valence shell of molecular bromine.** Frost, L.; Grisogono, A.M.; Weigold, E.; Brion, C.E.; Bawagan, A.O.; Tomasello, P.; Niessen, W. von. Flinders Univ. of South Australia, Bedford Park (Australia). Inst. for Atomic Studies. Aug 1987. 23p. Order Number DE90600780/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Submitted to Chem. Phys.

The binding energy spectrum of Br_2 has been recorded in both the outer and inner valence regions using electron momentum spectroscopy. The measurements are compared with the results of several Green's function calculations using different approximations and based on both polarized and unpolarized wave functions. The inner valence region, observed for the first time, is found to exhibit complex structure that is shown to be due to many-body effects, thus indicating a breakdown of the simple MO picture for ionization in this region. Momentum distributions for the three outer valence orbitals are also measured and compared with spherically averaged calculations using the target Hartree-Fock and plane wave impulse approximations. The effect of polarization functions in the basis set is investigated. Orbital density maps in both momentum and position space have been calculated and compared with the experimental measurements.

48253 (FIAS-R–192) **Electron scattering from atoms.** McCarthy, I.E. Flinders Univ. of South Australia, Bedford Park (Australia). Inst. for Atomic Studies. Jan 1988. 15p. Order Number DE90600801/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Invited talk at the Fifth Atomic and Molecular Physics and Quantum Chemistry Meeting.

Methods for electron scattering fall into two main classes : coupled channels methods involve an expansion of the total wave function in target eigenstates; R-matrix methods use a CI expansion for the whole electron-plus-target problem in a finite region of space outside which the electron feels no potential (or only the residual Coulomb potential in the case of charged targets). This problem has no continuum. It has discrete states with arbitrarily-high energies. The wave functions for the finite-range problem are matched to the known external wave functions at the boundary. Experimental data from studies on electron-hydrogen scattering, electron sodium scattering, electron scattering to singlet and triplet states of helium and electron scattering to and from magnesium are reviewed. The coupled-channels-optical model, coupled-channels with ad hoc pseudostates, and R-matrix theory are complete calculations in that no aspects of scattering are omitted, although approximations are of course made. The methods are in at least semi-quantitative agreement with each other where comparison is possible. Experiments in general are in agreement with each other. However for all atoms there are significant disagreements between theory and experiment for small differential cross sections. Total cross sections agree quite well.

48254 (FIAS-R–194) **Orbital momentum distributions and binding energies for the complete valence shell of molecular iodine.** Grisogono, A.M.; Pascual, R.; Weigold, E.; Bawagan, A.A; Brion, C.E.; Tomasello, P.; Niessen, W. von. Flinders Univ. of South Australia, Bedford Park (Australia). Inst. for Atomic Studies. Mar

1988. 22p. Order Number DE90600781/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

The complete valence shell binding energy spectrum (8-43eV) of I_2 has been measured by using electron momentum spectroscopy at 1000eV. The complete inner valence region, corresponding to ionization from the 10 σ_u and 10 σ_g orbitals, has been measured for the first time and shows extensive splitting of the ionization strength due to electron correlation effects in the ion. Many-body calculations using the Green's function method have been carried out and are compared with the data. Momentum distributions, measured in both the outer and inner valence regions, are compared with those given by SCF orbital wave functions calculated with a number of different basis sets. Computed orbital position and momentum density maps for oriented I_2 molecules are discussed in comparison with the measured and calculated spherically averaged momentum distributions.

48255 (FIAS-R–195) **Continuum effects in electron-helium total cross sections.** McCarthy, I.E.; Ratnavelu, K.; Weigold, A.M. Flinders Univ. of South Australia, Bedford Park (Australia). Inst. for Atomic Studies. Jun 1988. 15p. Order Number DE90600802/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

It is shown that total cross sections for the excitation of target states with large spectroscopic factors may be calculated accurately by representing the states by their leading independent-particle configurations. With this approximation coupled channels calculations agree only qualitatively with experimental total cross sections for the first five states of helium. R-matrix calculations using configuration interaction show better qualitative agreement. The complex polarisation potential for continuum excitations is described for two-electron atoms. When this is included in a coupled-channels optical calculation quantitative agreement with experiment is obtained for most states at 30, 50 and 100eV.

48256 (FIAS-R–197) **Ionisation of atomic hydrogen at intermediate momentum transfer.** McCarthy, I.E.; Weigold, E.; Zhang, X.; Zheng, Y. Flinders Univ. of South Australia, Bedford Park (Australia). Inst. for Atomic Studies. Aug 1988. 18p. Order Number DE90600803/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Relative differential cross sections for the asymmetric coplanar (e,2e) reaction have been measured in three energy-sharing regions, for two of which the ionisation peak is about 1 a.u. off the Bethe ridge. Momentum transfer is intermediate between large (binary) and small (dipole) values, where the distorted-wave impulse and second Born approximations respectively give a good account of the experimental data. In addition to these approximations the distorted-wave Born approximation is calculated. It is somewhat superior to the distorted-wave impulse approximation and very much better than the second Born approximation.

48257 (FIAS-R–198) **Differential cross sections and Stokes parameters for electron-magnesium scattering.** Mitroy, J.; McCarthy, I.E. Flinders Univ. of South Australia, Bedford Park (Australia). Inst. for Atomic Studies. Aug 1988. 28p. Order Number DE90600804/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Differential cross sections and Stokes parameters are reported for electron-magnesium scattering computed in the coupled channels approximation. A configuration-interaction representation is used for the five lowest singlet states which are included in the close-coupling expansion. The calculated differential cross sections for elastic scattering and the resonance $(3s^2)^1S^e$ -$(3s3p)^1P^o$ transition are in fair accord with experimental data, as are total cross sections for the resonance transition. There are only minor discrepancies in the comparison of the computed Stokes parameters with experiment.

48258 (IC–89/97) **19-state R-matrix calculation of the electron-photon coincidence parameters λ and —chi— for the electron excitation of 1^1s -> $3^{3,1}p$ in helium at 29.6 eV.** Fon, W.C.; Berrington, K.A.; Kingston, A.E. International Centre for Theoretical Physics, Trieste (Italy). May 1989. 10p. Order Number DE90600805/JAW. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS.

The R-matrix method has been employed to study the electron excitation of atomic helium. Nineteen states (n=1,2,3 and 4) have been included in the expansion of the total wave function. The results of this calculation are used to obtain the electron-photon coincidence parameters λ and —chi— for the excitation of 1^1s -> $3^{3,1}p$ at 29.6 eV. The calculated parameters λ and —chi— are compared with the only available experiments (Donnelly et al. 1988, Neil and Crowe 1988). (author). 14 refs, 2 figs.

48259 (IC–89/155) **Prediction of new tightly bound-states of $H_2^+(d_2^+)$ and "cold fusion"-experiments.** Barut, A.O. International Centre for Theoretical Physics, Trieste (Italy). Jun 1989. 6p. Order Number DE90600782/JAW. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS.

It is suggested that in the "cold-fusion" experiments of Fleischmann and Pons new tightly-bound molecular states of D_2^+ are formed with binding energies predicted to be of the order of 50 keV accounting for the heat released without appreciable fusion. Other tests of the suggested mechanism are proposed and the derivation of the new energy levels is given. (author). 3 refs.

48260 (INIS-mf–11515. pp. 83) **Kinetic boundary layer of the linearized Boltzmann equation at a partly absorbing sphere.** Hubmer, G.F. (Johannes Kepler Univ., Inst. fuer Theoretische Physik, Linz (Austria)); Titulaer, U. M. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48261 (INIS-mf–11515, pp. 84) **Structure of a boundary layer in a system of Brownian particles.** Kainz, A. (Johannes Kepler Univ., Inst. fuer Theoretische Physik, Linz (Austria)); Titulaer, U.M. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48262 (INIS-mf–11515, pp. 85) **Kinetic boundary layer on a sphere and the growth of droplets.** Widder, M.E. (Johannes Kepler Univ., Inst. fuer Theoretische Physik, Linz (Austria)); Titulaer, U.M. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48263 (INIS-mf–11515, pp. 84) **Solution of the non-linear Boltzmann equation for a homogeneous hard-sphere gas.** Kuegerl, G. (Technische Univ., Graz (Austria). Inst. fuer Theoretische Physik und Reaktorphysik); Schuerrer, F. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48264 (INIS-mf–11515, pp. 91) **Stopping power of water vapor for deuterium ions.** Bauer, P. (Johannes Kepler Univ., Linz (Austria). Inst. fuer Experimentalphysik); Mitterschiffthaler, C. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48265 (INIS-mf–11515, pp. 113) **Stopping cross section for fast ions.** Semrad, D. (Johannes Kepler Univ., Linz (Austria). Inst. fuer Experimentalphysik). Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order

Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.
Published in summary form only.

48266 (INIS-mf–11537, pp. 60) **Muon catalyzed fusion: effect of an electric field.** Robson, R.E. (James Cook Univ. of North Queensland, Townsville (Australia). Dept. of Physics); Ness, K.F. Australian Inst. of Nuclear Science and Engineering, Lucas Heights (Australia). 1989. (CONF-8902130–: 17. AINSE plasma physics conference, Lucas Heights (Australia), 6-8 Feb 1989). In *17th AINSE plasma physics conference: conference handbook.* Order Number DE90600936/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.
Abstract only.

48267 (INIS-mf–11537, pp. 29) **Vibrational and penning-type influences of impurities on excitation and ionization in nitrogen.** Ernest, A.D. (New England Univ., Armidale (Australia). Dept. of Physics); Fewell, M.P.; Haydon, S.C. Australian Inst. of Nuclear Science and Engineering, Lucas Heights (Australia). 1989. (CONF-8902130–: 17. AINSE plasma physics conference, Lucas Heights (Australia), 6-8 Feb 1989). In *17th AINSE plasma physics conference: conference handbook.* Order Number DE90600936/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.
'Short Communication.'

48268 (INIS-mf–11537, pp. 51) **New 1D-3V spherically symmetric PIC code.** Porteous, R.K. (Australian National Univ., Canberra (Australia). Plasma Research Lab.). Australian Inst. of Nuclear Science and Engineering, Lucas Heights (Australia). 1989. (CONF-8902130–: 17. AINSE plasma physics conference, Lucas Heights (Australia), 6-8 Feb 1989). In *17th AINSE plasma physics conference: conference handbook.* Order Number DE90600936/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.
Abstract only.

48269 (INIS-mf–11537, pp. 47) **Spectroscopic measurement of ion and atom temperatures in a metal vapour vacuum arc.** Studer, A. (Sydney Univ. (Australia). Dept. of Plasma Physics); James, B.W.; Falconer, I.S. Australian Inst. of Nuclear Science and Engineering, Lucas Heights (Australia). 1989. (CONF-8902130–: 17. AINSE plasma physics conference, Lucas Heights (Australia), 6-8 Feb 1989). In *17th AINSE plasma physics conference: conference handbook.* Order Number DE90600936/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.
'Short communication.'

48270 (INIS-mf–11537, pp. 48) **Cathode spot phenomena in continuous and pulsed vacuum arcs.** Swift, P. (Sydney Univ. (Australia). School of Physics); Falconer, I.S.; James, B.W.; McKenzie, D.R.; Brown, I.G. Australian Inst. of Nuclear Science and Engineering, Lucas Heights (Australia). 1989. (CONF-8902130–: 17. AINSE plasma physics conference, Lucas Heights (Australia), 6-8 Feb 1989). In *17th AINSE plasma physics conference: conference handbook.* Order Number DE90600936/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.
'Short communication.'

48271 (LA-UR–89-2500) **Zeeman interferometry.** Johnston, R.G. Los Alamos National Lab., NM (USA). 1989. 8p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-36. (CONF-890836–11: 33. SPIE annual international technical symposium on optical and optoelectronic applied science and engineering, San Diego, CA (USA), 6-11 Aug 1989). Order Number DE89015296/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The use of a two-frequency, Zeeman effect laser permits simple, stable, rapid, and highly accurate interferometry. There are a number of interesting applications. Three if them are discussed here.

48272 (LA-UR–89-2506) **New developments in the ab initio treatment of low energy electron collisions with molecules.** Schneider, B.I.; Rescigno, T.N.; McCurdy, C.W.; Langsfield, B.H. III. Los Alamos National Lab., NM (USA). 1989. 16p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-8907135–1: International conference on the physics of electronic and atomic collisions (ICPEAC), New Haven, CT (USA), 23-25 Jul 1989). Order Number DE89015294/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Although there has been substantial progress in the ab initio treatment of low energy electron scattering from small diatomic and polyatomic molecules in the last few years a number of problems still remain. Most current research has focused on the calculation of fixed nuclei scattering amplitudes in the static-exchange (SE) approximation. A few calculations have gone beyond this approximation to include electron correlation and/or vibrational and rotational effects, the latter often within the framework of model or parameterized potentials. In this article we review a number of developments which have occurred since the last electron molecule satellite meeting at Daresbury Laboratory in July 1987. Our primary objective shall be to point out the strengths and weaknesses of current computational capabilities and to describe a new approach to electron polyatomic collisions using the complex Kohn method. 30 refs., 1 fig.

48273 (LA-UR–89-2620) **The Los Alamos bright scurces: Review of the physics and the diagnostic technology.** Kyrala, G.A.; Schappert, G.T.; Jones, L.A.; Lee, P.H.Y.; Casperson, D.E.; Cobble, J.A.; Gomez, C.C.; Lee, S.A.; Taylor, A.J.; Tallman, C.R. Los Alamos National Lab., NM (USA). 1989. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-890836–10: 33. SPIE annual international technical symposium on optical and optoelectronic applied science and engineering, San Diego, CA (USA), 6-11 Aug 1989). Order Number DE89016994/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The investigation of many interesting physical phenomena in nature requires the generation of high-energy-density fields. To produce energy densities exceeding 10^7 J/cm^3 requires focusing a very powerful, very bright, short pulse laser. This talk will present a review of the physics that will be investigated with one such laser system, will describe the laser used, will describe the laser diagnostics, and will describe the physics diagnostics. The talk will emphasize the areas of research that will help the diagnostics of different aspects of these bright sources, and their interactions, especially the diagnostics of hot small volumes in picosecond time scales. 15 refs., 7 figs.

48274 (N–89-21726, pp. 23) **Measurement of angular differential cross sections at the SSL Atomic Scattering Facility.** Kvale, T.J. Alabama Univ., University, AL (USA). Dec 1988. (NASA-CR–183553;NAS–1.26:183553;CONF-8806391–: NASA/ASEE summer faculty fellowship program, Huntsville, AL (USA), 6 Jun 1988). In *Research Reports: 1988 NASA/ASEE Summer Faculty Fellowship Program.* Available from NTIS, PC A99/MF E03.

The design of the SSL Atomic Scattering Facility (ASF) located at the NASA/Marshall Space Flight Center as well as some of the initial experiments to be performed with it, are covered. The goal is to develop an apparatus capable of measuring angular differential cross sections (ADCS) for the scattering of 2 to 14 eV atomic oxygen from various gaseous targets. At present little is known about atomic oxygen scattering with kinetic energies of a few eV. This apparatus is designed to increase the understanding of collisions in this energy region. Atomic oxygen scattering processes are of vital interest to NASA because the space shuttle as well as other low earth orbit satellites will be subjected to a flux of 5 eV atomic oxygen on the ram surfaces while in orbit. The primary experiments will involve the measurements of ADCS for atomic oxygen scattering from gaseous targets (in particular, molecular nitrogen). These, as well as the related initial experiments involving thermal He scattering from N2 and O2 targets will be described.

48275 (ORNL/FTR–2825) **[Electron-impact ionization, Giessen, W. Germany, and visit to Darmstadt, W. Germany, February 28–March 12, 1988]: Foreign trip report.** Gregory, D.C. Oak Ridge National Lab., TN (USA). 28 Mar 1988. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017422/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Electron-impact ionization measurements were carried out in collaboration with the atomic physics group at the Strahlenzentrum of

Justus-Liebig Universitaet Giessen. The apparatus utilized for this work has been greatly improved over the last two years, and an ECR (Electron-Cyclotron-Resonance) ion source has expanded the range and variety of target ions available. Detailed and precise measurements were made for ionization of a number of Xe ions, and research plans of the two groups were extensively discussed. A brief visit to GSI Darmstadt included a check on progress of the beam line under construction for the measurement of dielectronic recombination of highly charged ions.

48276 (ORNL/FTR–3063) **[Physics of multicharged ions]: Foreign trip report, September 12–23, 1988.** Havener, C.C. Oak Ridge National Lab., TN (USA). 11 Oct 1988. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017372/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This trip provided the traveler the opportunity to present to an international group of scientists recent experimental work using the ion-atom merged-beams apparatus at Oak Ridge. Discussions led to a better understanding of present results and to directions for the future. A tour of the laboratory of the Atomic Physics group at CEN-G offered a direct comparison between a recently established user facility there and our ECR facility at Oak Ridge. The workshop in Krakow presented the traveler the opportunity to present recent advances in the understanding of the neutralization of multicharged ions at surfaces. A significant part of the work in this field has been done at Oak Ridge. A tour of laboratories at Jagellonian University gave the traveler the opportunity to see first hand experimental facilities of a Soviet-bloc country.

48277 (ORNL/FTR–3229) **[Auger effect symposium]: Foreign trip report, March 30, 1989–April 11, 1989.** Krause, M.O. Oak Ridge National Lab., TN (USA). 27 Apr 1989. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017381/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A plenary talk entitled "The Renaissance of an Effect" was given at the Auger Symposium, held in honor of Pierre Auger, the discoverer of the Auger Effect, on the occasion of his 90th birthday. The European Institute for Transuranium Elements was visited to discuss participation of the Institute in research on actinide elements to be done at the Advanced Light Source at Lawrence Berkeley Laboratory (LBL), Berkeley. At the University of Amsterdam, joint research with the group of C.A. de Lange, Chemistry Department, was discussed and a seminar on synchrotron radiation studies was presented.

48278 (UCRL–101228) **New theoretical approaches for studying electron collisions with small molecules.** Rescigno, T.N. Lawrence Livermore National Lab., CA (USA). 7 Jun 1989. 8p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890697–3: NATO Advanced Study Institute on non-equilibrium processes in partially ionized gases, Acquafredda di Maratea (Italy), 4-17 Jun 1989). Order Number DE89017543/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

There has been a recent resurgence of interest in the use of algebraic variational methods for studying a variety of collision problems. Much of this interest stems from the discovery that spurious singularities, which plagued the traditional methods, can be eliminated when the variational principle is formulated with outgoing-wave boundary conditions. Another reason for the recent activity is the obvious suitability of these methods to present-day supercomputers. My purpose here is to describe an implementation of the complex Kohn method, an algebraic variational technique, for studying electron collisions with small molecules, both liner and non-linear, unlike variational principles based on the integral form of the Schroedinger equation (Lippmann-Schwinger equation), the method only requires Hamiltonian matrix elements. I will also show how the formalism allows one to develop a variational principle for computing first-order properties, such as bound-free dipole transition amplitudes. I will show results for the electron-impact dissociation of hydrogen as a function of initial vibrational quantum number. I will also illustrate the method for polyatomic molecules with results for elastic scattering of electrons by formaldehyde. 14 refs., 2 figs.

48279 Vibrational properties of the π-bonded chain model of the Si(111) 2 x 1 surface. Alerhand, O.L. (Dept. of Physics, Univ. of Pennsylvania, Philadelphia, PA (US)); Allan, D.C.; Mele, M.J. vp of Computer-based microscopic description of the structure and properties of materials. Broughton, J.; Krakow, W.; Pantelides, S.T. Materials Research Society, Pittsburgh, PA (1986). (CONF-851217–: Materials Research Society meeting, Boston, MA (USA), 2-7 Dec 1985).

A tight-binding theory is used to study vibrational excitations of the π-bonded chain model of the Si(111)2x1 surface. Some aspects of the surface phonon spectrum are discussed. The authors study the charge fluctuations driven by the vibrational excitations and the surface conductivity associated with the phonons. They find that a longitudinal optical phonon on the surface chains dominates the surface conductivity.

48280 Fracture and flow via nonequilibrium molecular dynamics. Hoover, W.G. (Univ. of California and Lawrence Livermore National Lab., Livermore, CA (US)); DeLorenzi, G.; Moran, B.; Moriarty, J.A.; Ladd, A.J.C. vp of Computer-based microscopic description of the structure and properties of materials. Broughton, J.; Krakow, W.; Pantelides, S.T. Materials Research Society, Pittsburgh, PA (1986). (CONF-851217–: Materials Research Society meeting, Boston, MA (USA), 2-7 Dec 1985).

The scope of molecular dynamics problems designed to simulate materials properties is described, focussing on the limits computation imposes on space and time scales, as well as the limits theoretical understanding imposes on knowledge of interatomic forces. Five strategies for improving the efficiency of the simulation are described. Shock-induced solid-solid phase transformations are discussed to illustrate these ideas.

48281 Charge state dependence of K X-ray production in thin targets by multicharged silicon ions. McDaniel, F.D. (North Texas State Univ., Denton (USA). Dept. of Physics); Duggan, J.L.; Lapicki, G.; Miller, P.D. *Nuclear Instruments and Methods in Physics Research, Section B: Beam Interactions with Materials and Atoms (Netherlands)*, 42(4): 485-490 (Jul 1989). DOE Contract AC05-84OR21400. (CONF-8811181–: 4. international workshop on cross sections for fusion and other applications, College Station, TX (USA), 2-5 Nov 1988).

Typical data for target K-shell X-ray production cross sections in different charge states q are reviewed. Charge-state dependence is revisited and a small, shallow minimum in the cross section as a function of q, at q=10 or 11 for Si ions, is noted. A number of mechanisms that are considered show a monotonic decrease in cross sections with the decreasing q, which is contrary to the observed trend. We postulate that the increase of K-shell X-ray cross sections, as q becomes smaller, can be understood in terms of a larger ionization probability into L- and higher shells by a greater number of the projectile's electrons, which widens the excitation channels for the K-shell and, hence enhances the K-shell X-ray production cross section with the decreasing q. (orig.).

6404 Fluid Physics

Refer also to citation(s) 47857, 48175

48282 (AD-A–207017/5/XAB) **Investigation of r-f emissions from electric-field-dominated plasmas. Final scientific report, 31 January 1980-31 March 1989.** Roth, J.R. Tennessee Univ., Knoxville, TN (USA). Plasma Science Lab. 31 Mar 1989. 468p. (UTK-PSL–89-1). Available from NTIS, PC A20/MF A01.

Research includes efforts to confirm the theory of the geometric mean plasma emission. This process results from two interpenetrating electron beams in a Penning discharge. Effort were made on diagnostic and software development for the study of plasma turbulence, automatic reduction of Langmuir probe data, and correlation studies of plasma fluctuations and turbulence using digital time series analysis techniques based on the fast Fourier transform. The methods of chaos theory are applied to the investigation of plasma turbulence, using a commercially available software program. Extensive studies were conducted of fluctuations in a highly turbulent Penning discharge. By perturbing the plasma with a signal of known amplitude and frequency applied to an effector probe, one can

demonstrate the enhancement of plasma turbulence and the resulting turbulent heating of the plasma electron and/or ion population. These active modification experiments also demonstrated conditions under which a low-frequency modulation of the plasma by the effector probe could dampen the turbulent modes present in the unmodulated plasma. The damping of turbulent modes at higher frequencies, above 50 kilohertz, was as high as 10 to 20 db in some instances. This suggests a way to actively modify plasma turbulence and affect or reduce transport parameters which depend on the level of plasma turbulence. A diagnostic procedure was developed for measuring the effective collision frequency of electrons in plasmas due not only to binary collisions with other electron or neutral atoms, but also to turbulent collisions of the electrons that result when the electrons scatter off fluctuating electric fields.

48283 (AD-A–207985/3/XAB) **3D (three-dimensional) Navier-Stokes flow analysis for a large-array multiprocessor. Final technical report, 14 September 1988-29 February 1989.** Peery, K.M. Amtec Engineering, Inc., Bellevue, WA (USA). 17 Apr 1989. 59p. (AEI-TR–85290-01). Available from NTIS, PC A04/MF A01.

Computational fluid dynamics (CFD) software is an important analysis tool for engineers, particularly in the aerospace industry. CFD codes are, however, severely limited by the speed of current computers; several orders of magnitude increase in floating-point speed is necessary to effectively utilize CFD tools in engineering design. Parallel-processing computers will be available in the next few years with theoretical speeds approaching that required for effective use of CFD. Much work needs to the accomplished in developing CFD algorithms to make efficient utilization of these parallel computers. In this work one explicit and two implicit algorithms for solving the 3D Navier-Stokes equations were developed and benchmarked on the Encore Multimax, a shared-memory Multiple Instruction Multiple Data (MIMD) computer. Parallelism was obtained with domain decomposition. Parallel efficiencies ranged from 50 to 95% with 2 to 9 processors on 24 X 12 X 12 and 50 X 30 X 30 meshes.

48284 (DOE/ER/25061–1) **Analytical and numerical studies in flow development: Progress report, 1 July 1988 to Present.** Criminale, W.O.; Adams, L.M. Washington Univ., Seattle, WA (USA). Dept. of Applied Mathematics. 1989. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract FG06-88ER25061. Order Number DE89017380/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper discusses initial-value problems of the following topics: Couette flow; Viscous flow with boundaries; and Interface matching conditions. (LSP)

48285 (DOE/ER/72012–T8) **Numerical analysis, scientific computing and fundamental studies of fluid mechanics: Final report, April 1, 1986–March 31, 1989.** California Inst. of Tech., Pasadena, CA (USA). 1989. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract AS03-76ER72012. Order Number DE89017554/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper briefly discusses the following topics: vortex dynamics, vortical flow and separated flow; free surface flows at low Reynolds number; concurrent linear algebra routines; concurrent continuation and invariant manifolds; concurrent multigrid continuation methods; AUTO-software; Taylor-vortex flows; boundary conditions for infinite domains; numerical and analytical studies of evolutionary systems; numerical methods for stiff differential equations; vortex reconnection; and a study of finite amplitude bifurcations in plane Poiseuille flow. (LSP)

48286 (IC–89/94) **Unsteady hydromagnetic flow of a radiating gas in a vertical channel with axial temperature variation.** Bestman, A.R. International Centre for Theoretical Physics, Trieste (Italy). May 1989. 12p. Order Number DE90600934/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

The effect of transience on the hydromagnetic flow of a thermally radiating gas in a vertical channel is investigated under the assumption that the gas is optically thin, non-grey and non equilibrium; and the induced magnetic field may be neglected. Analytical solutions are obtained for thermal tooth pulses via Fourier series expansion. The effect of the variation of free convection, magnetic and radiation parameters on the shear stress and heat transfer at the walls are discussed quantitively. (author). 6 refs, 2 tabs.

48287 (LA-UR–89-2717) **Impulse time-integral function and Lagrangian analysis.** Forest, C.A. Los Alamos National Lab., NM (USA). [1989]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-890812–33: American Physical Society topical conference on shock compression of condensed matter, Albuquerque, NM (USA), 14-17 Aug 1989). Order Number DE89016997/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

In one-dimensional planar flow, the mechanical variables of stress, impulse, particle velocity, displacement and density are usual objects of measurement. They are related by conservation of mass and momentum, and it is shown here that they are partial derivatives of a single function of space and time. The function α, which is defined on the Lagrangian space and time domain, is a double integral of the particle velocity over mass and time. By integration over the mass first, the function α is shown to be a time integral of impulse, which is chosen to name the function. Because the measured variables of Lagrangian gauge experiments are related to partial derivatives of α, the entire data set may be least-square fit to the function α with a single parameter set. 4 refs., 6 figs.

48288 (UCID–21673) **GEOTOX multimedia compartment model user's guide supplement.** McKone, T.E. Lawrence Livermore National Lab., CA (USA). Sep 1988. 29p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE89016717/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This document provides information on additions and modifications made to the GEOTOX computer model since the original user's guide was issued. This document is not a substitute but a only a complement for the original guide. The version of GEOTOX described here is Version 1.2. This report is divided into two parts. The first part summarizes the changes made to GEOTOX since the original user's manual was issued. The second part provides a revised sample problem. Some of the major differences between Version 1.0 and Version 1.2 are: Version 1.2 explicitly calculates the convective residence time of gases and particles in the air compartments and uses the inverse of this value for the convective loss rate constant, whereas in Version 1.0 this loss rate was calculated by the user and introduced to the program as part of the overall reaction rate constant from air. The contaminant source term for GEOTOX A and GEOTOX B is now input as the source per unit area (mol/km^2) whereas, in Version 1.0 the sources were the total input for the area defined in the landscape input file. The output of GEOTOX A can be viewed graphically using a program that displays the distribution of contaminant concentration, fractional distribution, and reaction distribution among the compartments.

6450 High Energy Physics

Refer also to citation(s) 48172

48289 (DOE/ER/03065–54) **High energy physics: Progress report, December 1, 1988–November 30, 1989.** Fortney, L.R.; Goshaw, A.T.; Walker, W.D. Duke Univ., Durham, NC (USA). Dept. of Physics. Aug 1989. 53p. Sponsored by U.S. DOE Energy Research. DOE Contract AS05-76ER03065. Order Number DE89016743/JAW. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

This report discusses progress in high energy physics at Duke on the following topics: review of 1988–89 collider run; physics analysis and publication; hadroproduction of χ and direct photons using 300 GeV particle beams; hadroproduction of beauty; heavy flavor hadroproduction; hadrons-nucleus collisions; vector meson photoproduction; and straw tube tracking chamber R and D for the SSC.

6451 Particle Interactions and Properties - Experimental

Refer also to citation(s) 48177, 48338

48290 (BNL–43150) **Hermeticity requirements at SSC [Superconducting Super Collider].** Paige, F.E.; Wang, E.M. Brookhaven National Lab., Upton, NY (USA); Los Alamos National Lab., NM (USA). Jul 1989. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-890379–14: Workshop on calorimetry for the SSC, Tuscaloosa, AL (USA), 13-17 Mar 1989). Order Number DE89017832/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Missing transverse momentum is expected to be an important signature at the SSC, and the hermeticity of the calorimeter is the principal experimental limitation on measuring it. The requirements on the E_T^{miss} resolution are set by processes in which it provides the main background rejection. Two such processes, Higgs decay into $\ell^+\ell^-\nu\bar{\nu}$ and gluino decays giving missing p_T plus multiple jets, are discussed. 8 refs., 9 figs.

48291 (BNL–43151) **Pileup at the SSC [Superconducting Super Collider].** Paige, F.E.; Wang, E.M. Brookhaven National Lab., Upton, NY (USA); Lawrence Berkeley Lab., CA (USA). 1989. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-890379–15: Workshop on calorimetry for the SSC, Tuscaloosa, AL (USA), 13-17 Mar 1989). Order Number DE89017833/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The effects of pileup on physics signatures at the SSC are discussed. It is argued that pileup is not important for rare processes, including jets even of quite low p_T. It may be important for lepton isolation cuts. 3 refs., 6 figs.

48292 (BNL–43153) **Double prompt photon production at high transverse momentum by π^- on protons at 280 GeV/c.** Bonvin, E.; Bopp, R.; Carroll, L.J.; Cass, A.J.; Chung, S.U.; Donnat, M.; Dorsaz, P.A.; Feliks, M.E.; Fluri, L.; Jackson, J.N.; Kienzle-Focacci, M.N.; Lynch, J.G.; Martin, M.; Mathys, L.; Negus, P.J.; Perini, L.; Poultney, R.; Range, W.H.; Rosselet, L.; SnWA70 Collaboration. Brookhaven National Lab., Upton, NY (USA). 1 Jun 1988. 23p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-880867–27: 24. international Rochester conference on high energy physics, Munich (Germany, F.R.), 4-10 Aug 1988). Order Number DE90000032/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A search for pairs of high p_T prompt photons produced in hydrogen by a 280 GeV/c incident π^- beam has been carried out using a fine-grained electromagnetic calorimeter and the Omega spectrometer at the CERN SPS. Clear evidence for the existence of such events is found with a six standard deviation signal for $p_T >$ 3.0 GeV/c. The cross sections are consistent with beyond leading order QCD calculations. A discussion on the determination of α_s is also presented. 18 refs., 7 figs., 7 tabs.

48293 (BNL–43184) **Strangeness production in Si + Au interactions at 14.6 GeV/c per nucleon.** Hansen, O. Brookhaven National Lab., Upton, NY (USA). 1989. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-8905143–15: NATO advanced study institute international advanced course on the nuclear equation of state, Peniscola (Spain), 12 May - 3 jun 1989). Order Number DE90000029/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Production of strange particles in proton-proton interactions is systematically suppressed relative to the production of non-strange particles. A first order goal of experiments on strangeness production in nucleus-nucleus collisions is to find out if strangeness is suppressed in a way similar to the p-p interactions or whether the nuclear environment changes the behaviour. This paper investigates this possibility. 13 refs., 1 tab.

48294 (BONN-IR–88-62) **Correlated particle production in proton-antiproton interactions at c.m. energies from 200 to 900 GeV.** Holl, B. Bonn Univ. (Germany, F.R.). Physikalisches Inst.; Bonn Univ. (Germany, F.R.). Mathematisch-Naturwissenschaftliche Fakultaet. Dec 1988. 140p. (In German). Order Number DE90702767/JAW. Available from NTIS (US Sales Only), PC A07/MF A01.

In this report results on photon-charged two-particle pseudorapidity correlations, forward-backward multiplicity correlations, and general properties of photon production in proton-antiproton-collisions at centre of mass energies of 200 and 900 GeV are presented. The data were recorded with the UA 5 detector at the CERN Spanti pS collider operating in a pulsed mode. Besides general properties of photon production like the average photon yield and pseudorapidity distribution in soft proton-antiproton-collisions an estimate of the eta/π^0 ratio is given. The ratio of the average photon yield to the average number of charged particles exhibits a behaviour which is approximately independent of the centre of mass energy. The investigation of the photon-charged two-particle pseudorapidity correlations shows the existence of short-range correlations among photons and charged particles as already observed among charged particles. The study of forward-backward multiplicity correlations reveals a strong increase of the correlation strength with increasing centre of mass energy and a significant dependence on the phase space regions considered. (orig.).

48295 (CONF-8811171–5) **Asymmetry measurements in PP elastic scattering during polarized beam acceleration up to 4.4 GeV/c.** Shimizu, H.; Yoshida, H.; Ohnuma, H.; Kobayashi, Y.; Kobayashi, K.; Nakagawa, T.; Holt, J.A.; Glass, G.; Hiebert, J.C.; Kenefick, R.A.; Nath, S.; Northcliffe, L.C.; Hiramatsu, S.; Ikegami, K.; Mori, Y.; Sato, H.; Takagi, A.; Toyama, T.; Ueno, A.; Imai, K.;Texas A and M Univ., College Station, TX (USA). 1989. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER40399. From 17. INS international symposium on nuclear physics at intermediate energies; Tokyo (Japan); 15-17 Nov 1988. Order Number DE89017802/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

This is a brief report on the first measurement of the continuous momentum dependence of the analyzing power in proton-proton elastic scattering during polarized beam acceleration from 1.1 to 4.4 GeV/c. The measurement was done in the KEK-PS tunnel using an internal polyethylene thread target. The momentum bin size ranges from 5 to 18 MeV/c. Statistical uncertainty of the analyzing power is typically 0.5% per momentum bin. A small narrow structure has been observed at the incident proton momentum of 1.23 GeV/c. 2 refs., 4 figs.

48296 (DOE/ER/01195–T11) **Observation of $W \rightarrow \mu\nu$ decays in proton-antiproton collisions at $\sqrt{s} = 1.8$ TeV.** Westhusing, T.K. Illinois Univ., Urbana, IL (USA). Dept. of Physics. 1989. 106p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76ER01195. (UIUC-HEPG–89-5). Order Number DE89017447/JAW. Available from NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.

The production and subsequent decay to muon and neutrino of the W intermediate vector boson has been observed in $\bar{p}p$ collisions at a center-of-mass energy of 1.8 TeV at the Fermilab Tevatron collider. Details of the CDF detector are given and event selection criteria are developed. A cross section times branching ratio, based on a sample of three $W \rightarrow \mu\nu$ candidate events extracted from 27.2 $\pm$ 4.1 nb^{-1} of data taken in the 1987 collider run, is calculated to be $\sigma_W \times B_{W\rightarrow\mu\nu} = 0.59_{-0.32}{}^{+0.93}$ ($\pm$0.09) nb which is consistent with current theoretical predictions. 19 refs., 44 figs.

48297 (DOE/ER/01195–T12) **Study of muons associated with jets in proton-antiproton collisions at $\sqrt{s} = 1.8$ TeV.** Smith, D.A. Illinois Univ., Urbana, IL (USA). Dept. of Physics. 1989. 145p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76ER01195. (UIUC-HEPG–89-4). Order Number DE89017448/JAW. Available from NTIS, PC A08/MF A01; OSTI; INIS; GPO Dep.

Production of heavy quark flavors in proton-antiproton collisions with a center-of-mass energy of 1.8×10^{12} electron volts is studied for events containing hadronic jets with a nearby muon track, where both the jet and the muon are produced at large angles from the incident beams. The muon tracking system and pattern recognition are described. Detailed calculations of the muon background due to meson decay and hadron noninteractive punchthrough are presented, and other background sources are evaluated. Distributions of muon transverse momentum relative to the beam and to the jet axis agree with QCD expectations of semileptonic charm and beauty decay. Muon identification cuts and background subtraction leave 57.5 $\pm$ 17.1 muon-jet pairs, a rate consistent with the established production cross sections for charm and beauty quarks and the acceptance for minimum ionizing particles overlapping with nearby jets. A small dimuon sample clarifies the muon signature.

No signatures of undiscovered phenomena are observed in this new energy domain. 39 refs., 51 figs., 12 tabs.

48298 (DOE/ER/40399–2) **Study of neutron-proton interaction in the 300-700 MeV energy region: Progress report, September 1988–August 1989.** Northcliffe, L.C. Texas A and M Univ., College Station, TX (USA). Dept. of Physics. Aug 1989. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER40399. Order Number DE89017362/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The primary objective of the program is investigation of the nucleon-nucleon (NN) interaction, in the medium-energy region, in both elastic and inelastic channels. Most of the results of this research have already been published in refereed journals and will not be discussed here.

48299 (INIS-mf–11514, pp. 9-28) **Recent results from UAI.** Tao, C. (College de France, 75 - Paris (France). Lab. de Physique Corpusculaire). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

The few recent results from UAI Collaboration are presented. The production and decay of W and Z^0, monojets and production of dimuons and of an isolated large P_T lepton accompanied with 2 or 3 jets are analysed. 10 refs., 15 figs., 7 tabs. (M.F.W.).

48300 (INIS-mf–11514, pp. 29-63) **W^{+-} and Z^0 production in UA2 and tests of the standard model.** Battiston, R. (Perugia Univ. (Italy)). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

During the 1984 run UA2 collected data corresponding to an integrated luminosity of 310 nb^{-1} increasing the total collected luminosity to 452 nb^{-1}. An analysis of the production and decay of W^{+-} and Z^0 is presented, updating the results on the 4B properties. From measurements of the 4B masses, we measure the weak neutral current parameters $\sin^2\theta_W$ and p; the measurement of electroweak radiative corrections is also discussed. 21 refs., 15 figs. 2 tabs. (author).

48301 (INIS-mf–11514, pp. 65-82) **QCD in UA2.** Schacher, J. (Bern Univ. (Switzerland)). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

Data on the jet cross-sections at $\sqrt{s}$=630 GeV are compared with those obtained at $\sqrt{s}$=546 GeV. The agreement between the experimental results and the QCD prediction is good. Results on a search for an enhancement in the jet-jet invariant mass around 150 GeV are presented. A preliminary analysis on multi-jet events is also reported. 18 refs., 8 figs. (author).

48302 (INIS-mf–11514, pp. 83-100) **Search for monojet and multijet events with large missing P_T in the UA2 experiment.** Haenni, H. (Bern Univ. (Switzerland). Lab. fuer Hochenergiephysik). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

Using the full data sample ($\int$Ldt=310 nb^{-1}) collected during the 1984 p-barp Collider run ($\sqrt{s}$=630 GeV), the UA2 Collaboration has carried out a search for monojets and monophotons, as well as for multijet events with large missing transverse momentum. No significant signal could be isolated from background for either event type. The relevance of this result with respect to SUSY models is discussed. The method has been checked by measuring the process p-barp -W+X, W - ev through a study of events with an electromagnetic cluster and large P_T. 14 refs., 6 figs. (author).

48303 (INIS-mf–11514, pp. 101-102) **Determination of the leptonic neutral current couplings.** Klein, M. (Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik); Schlenstedt, S. Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

Short note. 4 refs., 3 figs., 1 tab.

48304 (INIS-mf–11514, pp. 143-156) **UCI mobile neutrino experiment.** Baumann, N. (Savannah River Plant, Aiken, S.C. (USA)); Greenwood, Z.; Gurr, H.; Kropp, W.; Mandelkern, M.; Price, L.; Reines, F.; Sobel, H. Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

Preliminary results are reported from the Irvine Neutrino Oscillation Experiment. This is an electron-antineutrino disappearance experiment at a reactor, and is sensitive to mass squared differences in the range ~.02 to ~6. eV^2. 4 refs., 5 figs. (author).

48305 (INIS-mf–11514, pp. 157-173) **Hadron production and search for new particles at DESY.** Criegee, L. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (Germany, F.R.)). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

Recent results from e^+e^- experiments at DESY in the fields of Υ decays, inclusive particle production, fragmentation mechanisms and search for New Particles are reported. 34 refs., 15 figs. (author).

48306 (INIS-mf–11514, pp. 335-346) **Recent results on coherent and incoherent particle production in ν-nucleus interactions below 30 GeV.** Nahnhauer, R. (Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

The coherent pion production reactions, inclusive strange particle production and cumulative proton production reactions are presented. The data come from an exposure of the heavy freon filled bubble chamber SKAT to the wide band (anti)neutrino beam of the Serpukhov 70 GeV proton accelerator. All three possible coherent pion production channels of weak charged and neutral current interactions in one experiment are analysed. From the inclusive strange particle reaction the total strange and charm particle cross section in the unexplores low energy region near the production threshold is calculated. For cumulative protons experimental hints that this process is due to secondary interactions in the nucleus instead of scattering on nuclear clusters is found. 16 refs., 13 figs. (M.F.W.).

48307 (INIS-mf–11514, pp. 383-395) **Experimental limits on the nucleon lifetime from the Irvine -Michigan - Brookhaven (IMB) detector.** Bionta, R.M. (Lawrence Livermore National Lab., CA (USA)); Blewitt, G.; Bratton, C.B. and others. Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

Lower limits of the partial lifetimes for 32 nucleon decay modes are obtained from 417 live day exposure of the water Cherenkov IMB detector. During this period 401 events originating inside a 3300 ton fiducial volume were observed. They are consistent with the expected background of atmospheric ν interactions. Twenty one of the events can be interpreted as either ν interactions or nucleon decays into modes without a neutrino in the final state. 3 refs., 3 figs., 2 tabs. (author).

48308 (INIS-mf–11514, pp. 321-326) **Polarisation effect of the rho-meson in interactions at 5.7, 12, 22.5 GeV/c.** Simak, V. (Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Fyzikalni Ustav). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

The rho^0 spin alignment is studied. An analysis is based on inclusive p-barp data at 22.4 and 12 GeV/c and on fitted channels p-barp -> $2\pi^+2\pi^-$ + neutrals of 5.7 exclusive data. 6 refs., 4 figs. (M.F.W.).

48309 (INIS-mf–11514, pp. 489-515) **Recent results on weak decays from DESY.** Strom, D. (Wisconsin Univ., Madison, WI (USA). Dept. of Physics). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

Recent results from e^+e^- experiments at DESY on the following topics are reported: observation of the decay D^0 -> K-bar^{0}PHI, D^0 - D-bar^0 mixing, D^0 lifetime, bottom hadron lifetime and the limit on the tau neutrino mass. 25 refs., 13 figs., 1 tab. (author).

48310 (INIS-mf–11514, pp. 543-582) **Overview of νN and ν-barN interactions.** Abramowicz, H. (Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

A short review of knowledge on neutrino nucleon interactions is presented. The topics which are covered concern mainly our understanding of weak interactions and the nucleon structure. Exceptionally the like sign dimuon production is mentioned. 23 refs., 20 figs., 5 tabs. (M.F.W.).

48311 (INIS-mf–11514, pp. 583-601) **HERA: the physics and the machine.** Schmueser, P. (Hamburg Univ. (Germany, F.R.). 2. Inst. fuer Experimentalphysik). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

The physics programme of the large electron-proton colliding beam facility HERA is reviewed and a description of the accerelator project is given. 19 refs., 13 figs. (author).

48312 (INIS-mf–11514, pp. 529-542) **Q^2 and W dependence of multiplicities in μ^+p scattering at 280 GeV.** Rondio, E. (Institute of Physics, Warsaw University Branch, Bialystok, (Poland)). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

Properties of hadron multiplicities in 280 GeV μ^+p interactions have been investigated. The c. m. energy dependence in the range from 4 to 20 GeV as well as variation with Q^2 are presented. No variation faster than logarithmic is seem in the energy range of this experiment. Increases in both the mean charged hadron multiplicity and the K^0 yield are observed with increasing Q^2 for fixed c. m. energy W. The detailed study of fragmentation function shows that extra particles are produced mainly in the central region of x_F. 6 refs., 7 figs. (author).

48313 (INIS-mf–11514, pp. 517-528) **Search for higher twist effects in hadronic distributions from μp interactions.** Nassalski, J. (Institute of Nuclear Research, Warsaw (Poland)). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

The higher twist effects predicted by Berger have been searched for in the hadronic distributions from μp interactions. The data are not compatible with the predicted magnitude of the effects. 6 refs., 6 figs. (author).

48314 (INIS-mf–11515, pp. 18) **Novel methods for reconstruction of events in experimental high-energy physics.** Fruehwirth, R. (Oesterreichische Akademie der Wissenschaften, Vienna (Austria). Inst. fuer Hochenergiephysik). Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48315 (INIS-mf–11515, pp. 78) **Measurement of total neutron cross-sections for determination of the electric polarizability of the neutron.** Harvey, J.A. (Oak Ridge National Lab., TN (USA)); Hill, N.W.; Horen, D.J.; Riehs, P.; Schmiedmayer, J. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48316 (JINR-E–2-88-363) **Proceedings of the seminar Physics of e^+e^- interactions.** Joint Inst. for Nuclear Research, Dubna (USSR). 1988. 111p. (CONF-8712145–: 3. seminar on physics of e^+e^- interactions, Dubna (USSR), 8-9 Dec 1987). Order Number DE89018001/JAW. Available from NTIS (US Sales Only), PC A06/MF A01 - OSTI; INIS.

Individual papers in these proceedings are separately indexed. (DLC)

48317 (JINR-E–2-88-363, pp. 68-73) **Physics and Monte Carlo on DELPHI.** Ridky, J. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8712145–: 3. seminar on physics of e^+e^- interactions, Dubna (USSR), 8-9 Dec 1987). In *Proceedings of the seminar Physics of e^+e^- interactions.* Order Number DE89018001/JAW. Available from NTIS (US Sales Only), PC A06/MF A01 - OSTI; INIS.

A short review of simulation program DELSIM and physical processes simulated by it are given.; Monte Carlo simulations are necessary for the following tasks; technical proposal, detector construction, data analysis and physics analysis. The general structure of DELSIM program for full simulation of DELPHI detector is presented. The packages ATOM and DVP are intended to allow checking of data base and event processing with graphic stations.

48318 (LA-UR–89-2779) **The Baksan gallium solar neutrino experiment.** Gavrin, V.N.; Abazov, A.I.; Abdurashitov, D.N.; Anosov, O.L.; Bychuk, O.V.; Danshin, S.N.; Eroshkina, L.A.; Faizov, E.L.; Gayevsky, V.I.; Girin, S.V. SAGE Collaboration. Los Alamos National Lab., NM (USA). [1989]. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-890520–2: International conference: inside the sun, Versailles (France), 22-26 May 1989). Order Number DE89016036/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

A radiochemical ^{71}Ga-^{71}Ge experiment to determine the integral flux of neutrinos from the sun has been constructed at the Baksan Neutrino Observatory in the USSR. Measurements have begun with 30 tonnes of gallium. The experiment is being expanded with the addition of another 30 tonnes. The motivation, experimental procedures, and present status of this experiment are presented. 43 refs., 1 fig., 1 tab.

48319 (ORNL/FTR–2919) **[Proton-nucleus collisions]: Foreign trip report, April 11, 1988–June 11, 1988.** Awes, T.C. Oak Ridge National Lab., TN (USA). 22 Jun 1988. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017281/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler participated in the start-up and operation of the WA80 setup for an experiment using 200-GeV/c proton beams incident on targets of C, Al, Cu, Ag, and Au. The traveler attended a WA80 collaboration meeting in which recent results and future plans were discussed. The traveler also presented a talk on WA80 calorimeter results at the Workshop on Relativistic Heavy-Ion Physics in Erice, Italy. The traveler attended several meetings at CERN in which several possible configurations suitable for experiments with lead beams at CERN were discussed. After the proton run period, the traveler completed studies of a new approach to handle the problem of photon combinatorials. This problem must be dealt with in analyzing the results from the SAPHIR detector of WA80 or from a similar but larger detector for an upgraded WA80 experiment. Finally, the traveler attended the Third International Conference on Nucleus-Nucleus Collisions in Saint-Malo, France.

48320 (SLAC-PUB–5047) **B identification by topology with the SLD Detector.** Atwood, W.B. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Aug 1989. 4p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-8906210–1: Workshop on B-factories and related issues, Blois (France), 26 Jun - 1 jul 1989). Order Number DE89016947/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

At both the SLC and LEP large samples of $Z^0 \rightarrow b\bar{b}$ will soon be available. The challenge is to find experimental techniques to inclusively tag and identify the various particles b quarks may fragment into. The work described here makes use of the new generation of close-in tracking devices which will achieve unparalleled precision in particle trajectory resolution. Some of these devices provide three-dimensional information which is crucial in solving the pattern recognition problem discussed below. In the case where only two-dimensional information is available other than tracking information may be required. The tracking system is used to extrapolate tracks into some preselected point. The result is a picture of many crossing tracks and the problem is to find the real vertices among all the possible combinations. 1 ref., 3 figs., 1 tab.

48321 (SLAC-PUB–5052) **Recent results on hadronic D_s and D meson decays from the Mark III.** Adler, J.; Bai, Z.; Blaylock, G.T.; Bolton, T.; Brient, J.C.; Browder, T.E.; Brown, J.S.; Bunnell, K.O.; Burchell, M.; Burnett, T.H.; Cassell, R.E.; Coffman, D.; Cook, V.; Coward, D.H. Mark III Collaboration. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jul 1989. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515;AC02-76ER01195;AC02-87ER40318;AC03- (CONF-8908142–1: 14. international symposium on lepton and photon interactions, Stanford, CA (USA), 7-12 Aug 1989). Order Number DE89016948/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Recent results on hadronic D_s and D decays from the Mark III collaboration are presented. The absolute branching ratio $B(D_s^+ \rightarrow \phi\pi^+)$ is studied by searching for fully reconstructed $e^+e^- \rightarrow D_s^{*\pm}D_s^{\mp}$ events using seven hadronic decay modes of the D_s^+. A limit of $B(D_s^+ \rightarrow \phi\pi^+) < 4.1\%$ at 90% C.L. is obtained. Evidence is presented for the decay $D_s^+ \rightarrow f_0(975)\pi^+$ which agrees with a recent experimental observation. Upper limits are set for the relative branching ratios $B(D_s^+ \rightarrow \eta\pi^+)/B(D_s^+ \rightarrow \phi\pi^+) < 2.5$ and $B(D_s^+ \rightarrow \eta'\pi^+)/B(D_s^+ \rightarrow \phi\pi^+) < 1.9$, where the η is studied in both the $\gamma\gamma$ and the $\pi^+\pi^-\pi^0$ decay modes and the η' in the $\eta\pi^+\pi^-$, $\eta \rightarrow \gamma\gamma$ decay chain. The resonant substructure of $D^0 \rightarrow K^-\pi^+\pi^-\pi^+$ and $D^+ \rightarrow \{$ bar_K$\}\,^0\pi^+\pi^-\pi^+$ is studied. The branching ratio of $D^0 \rightarrow \{$ bar_K$\}\,^{*0}\rho^0$ is found to be smaller than the theoretically expected whereas the decay modes $D^0 \rightarrow \alpha_1^+K^-$ and $D^+ \rightarrow \alpha_1^+\{$ bar_K$\}^0$ are found to be large and account for 50% of these final states. 33 refs., 9 figs., 2 tabs.

48322 **Electromagnetic production of hypernuclei.** Cohen, J. (Case Western Reserve Univ., Cleveland, OH (USA). Dept. of Physics). *International Journal of Modern Physics A (USA)*, 4(1): 1-78 (1989).

The authors review the results of recent studies and calculations of γ-hypernuclear excitations via electromagnetic probes [the (e,e'K$^+$) and (γ, K$^+$) reactions]. After discussing the importance of the problem, they present and analyze the theoretical features of a model (based upon Feynman diagrams) for studying the process. The special kinematics of the nuclear (e,e'K$^+$) reaction, involving high momentum transfers, is discussed. They then present cross section calculations. Using first a nonrelativistic nuclear structure model, they present results for the exclusive and inclusive electromagnetic hypernuclear excitations and for a large range of nuclear masses. Next, the authors calculate cross sections using the fully-relativistic form of the transition operator and relativistic Dirac-nuclear-and hypernuclear-structure model. In this context, they analyze the effects of the large scalar and vector potentials of the relativistic model and of the Dirac-spinor wave functions of the proton and the γ-hyperon, on the calculated quantity. The relativistic-model calculations are presented for both pseudoscalar (PS) and pseudovector (PV) KN γ vertex couplings and they discuss in detail the different theoretical predictions obtained in the two cases.

6452 Particle Interactions and Properties - Theoretical

Refer also to citation(s) 48239, 48301, 48399, 48404, 48422, 48569

48323 (ANL-HEP-CP–89-80) **Symmetry, topology and helicity in $D_s \rightarrow \omega\pi$ and $D_s \rightarrow \rho\pi$ decays.** Lipkin, H.J. Argonne National Lab., IL (USA). 1 Aug 1989. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. (CONF-8906204–3: International symposium on heavy quark physics, Ithaca, NY (USA), 13-17 Jun 1989). Order Number DE89016913/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Diagrams contributing to $D_s \rightarrow \omega\pi$ and $D_s \rightarrow \rho\pi$ decays are classified by topology as OZI-forbidden or disconnected, OZI-allowed or connected; by helicity as helicity-conserving, with helicity flips on both outgoing quark lines. The $D_s \rightarrow \omega\pi$ decay has an exotic final state and is forbidden for all annihilation diagrams which go via an intermediate state containing a single quark-antiquark pair and less than two additional gluons. It is also forbidden for helicity-conserving OZI-allowed diagrams, which are expected to be dominant and are allowed for $D_s \rightarrow \rho\pi$ decays. 3 refs.

48324 (CONF-8906210–2) **B factory via conversion of 1 TeV electron beams into 1 TeV photon beams.** Mtingwa, S.K.; Strikman, M. Argonne National Lab., IL (USA). 1989. 10p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From Workshop on B-factories and related issues; Blois (France); 26 Jun - 1 jul 1989. Order Number DE89017692/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

We derive formulae which describe the interaction of laser beams with electron beams. Specializing to the case of 1 TeV electron

beams from the future generation of electron linear accelerators, we calculate the production rate of backscattered 1 TeV photons, and using these photons, we show that it is possible to organize the photoproduction of beauty particles so as to measure $10^9 b\bar{b}$ pairs per year. This should be adequate to study rare decays and CP violation in B meson decay. 9 refs., 1 fig.

48325 (DOE/ER/40215–T9) **The electric dipole moment of the W boson and the radiation amplitude zero: [Revised].** Boudjema, F.; Hamzaoui, C.; Samuel, M.A.; Woodside, J. Oklahoma State Univ., Stillwater, OK (USA). Dept. of Physics. Feb 1989. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-85ER40215. Order Number DE89017788/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The effect of an electric dipole moment (e.d.m.) of the W bosom is studied in the radiative decay $W^- \rightarrow \bar{u}d\gamma$. It is shown that the radiation amplitude zero which is present in this process provides a sensitive test of the possible compositeness of the W. The two possibilities, a large e.d.m. ($\lambda \geq 1$) and a significant magnetic moment ($\kappa \neq 1$) can in principle be distinguished. 10 refs., 7 figs.

48326 (IC–89/95) **Effective QCD chiral Lagrangian for pions and vector mesons and hidden local symmetry.** Novozhilov, V.Yu. International Centre for Theoretical Physics, Trieste (Italy). May 1989. 8p. Order Number DE90601088/JAW. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS.

Starting from the QCD path integral in the low energy region we derive an effective Lagrangian for pions and vector mesons as gauge bosons of the hidden local symmetry. We use two chiral anomalies related to (a) the standard chiral group and current quarks and (b) the hidden symmetry group and constituent quarks. The effective Lagrangian depends on one parameter F_π, the pion decay constant. (author). 15 refs.

48327 (IC–89/109) **Size of systems in massless collective states.** Mankoc-Borstnik, N. International Centre for Theoretical Physics, Trieste (Italy). May 1989. 14p. Order Number DE90601087/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Composite systems with the product of mass and size close to zero are discussed. This product is smaller than 10^{-6} for quarks and leptons in composite models. Since the size of the pion, dynamically generated in the Nambu Jona-Lasinio model turns out to be finite even in the chiral limit, the product of the mass and the size of the pion in the chiral limit is infinitesimally small. In this sense the pion behaves similarly to quarks and leptons in composite models. (author). 21 refs, 2 figs.

48328 (INIS-mf–11514, pp. 103-117) **Spontaneous parity breaking by quantum corrections.** Olechowski, M. (Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej); Spalinski, M. Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

Spontaneous gauge symmetry breaking by quantum corrections is considered in the context of the left-right symmetric model of the electroweak interactions. We find that a realistic model can be constructed only if the theory includes heavy gauge singlet fermions. 12 refs. (author).

48329 (INIS-mf–11514, pp. 119-142) **Effective Lagrangian describing new vector mesons in a strong interacting Higgs sector.** Dominici, D. (Geneva Univ. (Switzerland). Inst. de Physique Theorique). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

Using the hidden symmetry formulation of the nonlinear σ-model, an effective Lagrangian describing a new triplet of vector mesons arising from a strong Higgs sector is presented. Some phenomenological consequences are also discussed. 12 refs., 3 figs., 3 tabs. (author).

48330 (INIS-mf–11514, pp. 175-186) **Radiative corrections in two-photon physics, including effects from non-peripheral diagrams.** Neerven, W.L. van (Dortmund Univ. (Germany, F.R.). Inst. fuer Physik); Vermaseren, J.A.M. Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

We give a review of the full virtual and soft radiative corrections to the two-photon reaction $e^+e^- \rightarrow e^+e^-X$ where X is a pointlike pseudo scalar particle. We find that the effect of the non-peripheral diagrams is negligible so that this class of graphs can be ignored in all two-photon reactions. 12 refs., 6 figs. (author).

48331 (INIS-mf–11514, pp. 195-199) **Logarithmic asymptotics of amplitudes in QCD.** Kirschner, R. (Leipzig Univ. (German Democratic Republic). Sektion Physik). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

The amplitude of some process in a given order of perturbation theory is considered and a further loop is added in all possible ways. 5 refs., 3 figs. (M.F.W.).

48332 (INIS-mf–11514, pp. 281-291) **Possible evidence for supersymmetry in hadron spectra.** Bohm, A. (Texas Univ., Austin, TX (USA). Dept. of Physics). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

Following the example of nuclear physics a tower of meson resonances and a tower of baryon resonances are combined into a supertower described by Osp. This is phenomenologically justified by the approximate equality of the mass splitting for these mesons and baryons. 9 refs., 1 fig. (author).

48333 (INIS-mf–11514, pp. 293-299) **Spin forces in hadron spectroscopy: quark model versus electromagnetic spin interactions.** Barut, A.O. (Geneva Univ. (Switzerland). Inst. de Physique Theorique). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

The spin-orbit and spin-spin potentials in hadron spectroscopy are usually treated as a perturbation to an unperturbed Hamiltonian both in nonrelativistic and relativistic models. We study these terms nonperturbatively; they are not uniformly small and indeed modify in general the unperturbed potential in such a way that the original unperturbed bound state completely disapper. Some remedies are discussed and a comparison is made with the spin forces in QED. 7 refs. (author).

48334 (INIS-mf–11514, pp. 257-262) **Baryon charges of chiral bags.** Zalewski, K. (Institute of Nuclear Physics, Cracow (Poland)). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8*

Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985. Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

The baryon number for a chiral bag is analysed for massless quarks and when the fermion mass not = 0. It is shown how can be performed the calculation for one dimensional bag. 11 refs., 1 fig. (M.F.W.).

48335 (INIS-mf–11514, pp. 263-270) **Metric bag model of hadrons.** Romaniuk, M. (Institute of Physics, Warsaw University Division, Bialystok, (Poland)). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

The new model of hadrons based on bag approach and "strong gravity" philosophy is given. We have calculated in this model (called here the metric bag model) some properties of light hadrons. The agreement with experimental values is excellent. 5 refs., 3 tabs. (author).

48336 (INIS-mf–11514, pp. 313-319) **Leading particle effect at higher energies.** Blazek, M. (Slovenska Akademia Ved, Bratislava (Czechoslovakia). Fyzikalny Ustav). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

It is shown that the presently available data on charged multiplicities prefer such a modification of the KNO scaling function which involves an energy dependent measure of the leading particle effect. 18 refs. (author).

48337 (INIS-mf–11514, pp. 375-382) **On production of supersymmetric Majorana particles in polarized e^+e^- collisions.** Bilenky, S.M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics); Christova, E.Ch.; Nedelcheva, N.P. Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

Production of two different (supersymmetric?) Majorana fermions in collisions of longitudinally polarized e^+ and e^- is considered on the basis of general invariance principles. Polarization characteristics of the process are discussed in detail. Possible methods for checking OP and CPT-invariance are suggested. Some tests which would allow us to distinguish whether the final particles are of Majorana or Dirac type are proposed. 6 refs. (author).

48338 (INIS-mf–11514, pp. 301-312) **Novel approach to scaling in multiplicity.** Szwed, R. (Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

Problems concerning scaling in multiplicity are briefly reviewed and the standard approach (KNO scaling) is compared with the new one (KNO-G scaling). It is shown that, with the new approach , the pp multiplicity data obey multiplicity scaling perfectly within the whole available centre-of-mass energy range from 2.5 to 62.2 GeV. However, the scaling is broken by the CERN Super Proton Synchrotron Collider pp multiplicity data of experiment UA5. 16 refs., 6 figs. (author).

48339 (INIS-mf–11514, pp. 327-334) **Note on the constituent quark cross sections and average charged multiplicities.** Simak, V. (Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Fyzikalni Ustav); Vavra, J. Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

We have revised additive quark model for inelastic hadronic cross sections with its implications to the average charged multiplicities. The correction to additive quark model (AQM) is on the level of 3 mb only if we take into account all possible quark-quark cross sections. We have attributed average charged multiplicities to the constituent quarks cross sections and found some regularities according to flavour of the quarks. 7 refs., 5 figs. (author).

48340 (INIS-mf–11514, pp. 467-488) **Standard electroweak model and beyond: a review.** Pham Quang Hung (Virginia Univ., Charlottesville, VA (USA). Dept. of Physics). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

A pedagogical review of the standard electroweak model is followed by a phenomenological analysis of electroweak interactions which led to a partial confirmation of the standard model. The phenomenology of the W and Z bosons is briefly reviewed with the purpose of showing the striking agreement between experiment and the standard model. The preceding review is followed by speculations on the unexplored Higgs sector of the model. Aspects of strongly coupled Higgs models are discussed in this section. The review is ended with a discussion of what could lie beyond the standard model. 29 refs. (author).

48341 (INIS-mf–11514, pp. 661-667) **Constraints on multiplicity distribution of quark pairs.** Wroblewski, A. (Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

Constraints have been obtained on quark-antiquark multiplicity distribution in quark jets by adjusting parameters of Monte-Carlo jets to fit the experimental relation between the average multiplicity of charged final state hadrons and the dispersion of their multiplicity distribution. 6 refs., 4 figs. (author).

48342 (INIS-mf–11514, pp. 655-659) **Higher vector mesons in nucleon form factors.** Krupa, D. (Slovenska Akademia Ved, Bratislava (Czechoslovakia). Fyzikalny Ustav); Kundrat, V.; Maesiar, P. Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

The consistency of higher vector meson states existence with the isovector electric nucleon form factor data has been checked. Besides the well established rho(770), rho(1600) and the not so well established rho(1250) the consistency is confirmed for yet another vector meson with the mass just above 2 GeV so far unestablished but possibly already observed. 10 refs. (author).

48343 (INIS-mf–11515, pp. 14) **Quark-gluon plasma.** Satz, H. (European Organization for Nuclear Research, Geneva (Switzerland)). Johannes Kepler Univ., Linz (Austria). 1989. (In German).

(CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.
Published in summary form only.

48344 (INIS-mf–11515, pp. 77) **Quark confinement in supersymmetric QCD.** Gerstenmayer, E. (Techn. Univ. Vienna, Inst. fuer Kernphysik, Vienna (Austria)); Faber, M.; Feilmair, W.; Markum, H.; Mueller, M. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.
Published in summary form only.

48345 (INIS-mf–11515, pp. 128) **Many-point meson greens functions in the strong-coupling limit of the lattice quantum chromodynamics.** Gasser, I. (Techn. Univ. Vienna, Inst. fuer Kernpysik, Vienna (Austria)); Faber, M.; Kainz, W.; Markum, H. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.
Published in summary form only.

48346 (INIS-SU–113/A, pp. 13-14) **Heavy quarkonia in smoothed potential.** Khvingiya, N.L. AN SSSR, Moscow (USSR). Fizicheskij Inst. 1989. (In Russian). (T–23539). In *Experimental and theoretical physics. Collection.* Order Number DE89018003/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.
Kratkie soobshcheniya po fizike.; v. 1.
The calculation of energy spectra of bottomonium and toponium in smoothed potential is made. The reproduction of the levels in a quasiprecisesolved model for this potential is possible when smoothing parameters δ equals 0.86 GeV^{-1}. 5 refs.; 1 tab.

48347 (INIS-SU–113/A, pp. 38-40) **On exclusive structure functions and inclusive hadron spectra near X=1.** Rojzen, I.I. AN SSSR, Moscow (USSR). Fizicheskij Inst. 1989. (In Russian). (T–23539). In *Experimental and theoretical physics. Collection.* Order Number DE89018003/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.
Kratkie soobshcheniya po fizike.; v. 1.
Exclusive distributions of valent quarks in pion and proton are expressed via quark inclusive structure functions near the value of total energy of valent quarks X=1. On the basis the relation of the latter to inclusive spectra of fast hadrons in πp- and pp-interactions during arbitrary transfers of transverse momentum is found. 4 refs.

48348 (IPNO-DRE–88-28) **Hyperon-nucleon final state interaction in a pp -> K^+X experiment and the H_1^+ (2130) S = - 1 strange dibaryon.** Frascaria, R.; Siebert, R.; Didelez, J.P.; Blanpied, G.; Reposeur, T.; Warde, E.; Boivin, M.; Yonnet, J.; Bovet, E.; Egger, J.P. Paris-11 Univ., 91 - Orsay (France). Inst. de Physique Nucleaire. 1988. 14p. (CONF-8809143–: International symposium on hypernuclear and low-energy kaon physics, Padova (Italy), 12-16 Sep 1988). Order Number DE90701549/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.
A pp -> K^+X experiment was performed with high resolution to study λp and σN in a large range of momentum transfer and missing mass, in order to study the cusp effect which hinders the characterisation of the structure near the $\sigma^+ n$ threshold as dynamical or kinematical. The difficulty in explaining the cusp effect is related to the large SU(3) breaking. It is argued that the present experiment provides a good means of obtaining the information required, but detailed analysis of results is not yet complete.

48349 (JINR-E–2-88-363, pp. 6-14) **Possibility of studying the vertex $W\gamma W$ in the process $e^+e^-\to\gamma\nu\nu$-bar.** Borisov, G.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Serpukhov (USSR). Inst. Fiziki Vysokikh Ehnergij); Larin, V.N.; Tikhonov, F.F. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8712145–: 3. seminar on physics of e^+e^- interactions, Dubna (USSR), 8-9 Dec 1987). In *Proceedings of the seminar Physics of e^+e^- interactions.* Order Number DE89018001/JAW. Available from NTIS (US Sales Only), PC A06/MF A01 - OSTI; INIS.
The detailed consideration of the $e^+e^-\to\gamma\nu\nu^-$bar process at high energies (LEP)-(2) in the standard model is performed. The three-bosonic vertice of $W\gamma W$ interaction is studied. Feynman diagrams of the process are presented. The behaviour of the cross sections is shown. 14 refs.; 5 figs.

48350 (JINR-E–2-88-363, pp. 15-19) **On the process $e^+e^-\to Z^0\nu\nu$-bar near the Z^0 threshold.** Bardin, D.Yu.; Bilenky, M.S. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8712145–: 3. seminar on physics of e^+e^- interactions, Dubna (USSR), 8-9 Dec 1987). In *Proceedings of the seminar Physics of e^+e^- interactions.* Order Number DE89018001/JAW. Available from NTIS (US Sales Only), PC A06/MF A01 - OSTI; INIS.
The aim of this paper is to calculate analytically and to evaluate numerically the differential cross-section $d\sigma/dm$ of the process $e^+e^-\to Z^0\nu_e',\nu\text{-bar}_e'$ with a subsequent Z^0-decay into a lepton pair where m is the effective mass of the final lepton pair. All calculations are carried out near the Z^0 threshold, that is under the assumption $0<S-M_Z^2<<S$, $0<S-m^2<<S$, where S is the invariant of the reaction. That assumption corresponds to the conditions of the experiments at LEP(I) and SLS colliders, with $\sqrt{S}\simeq 100$ GeV. 5 refs.; 5 figs.; 1 tab.

48351 (JINR-E–2-88-363, pp. 33-60) **Behaviour of σ_{tot} ($e^+e^-\to$hadrons) in QCD and in theories with scalar quarks.** Gorishny, S.G. (Joint Inst. for Nuclear Research, Dubna (USSR)); Kataev, A.L.; Larin, S.A. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8712145–: 3. seminar on physics of e^+e^- interactions, Dubna (USSR), 8-9 Dec 1987). In *Proceedings of the seminar Physics of e^+e^- interactions.* Order Number DE89018001/JAW. Available from NTIS (US Sales Only), PC A06/MF A01 - OSTI; INIS.
The available theoretical information about the behaviour of the ratio $R(S)=\sigma_{tot}$ ($e^+e^-\to\mu^+\mu^-$) in various realistic models of strong interactions is summed. The main QCD parameters, namely, the QCD coupling constants, the scale parameter Λ and the quark masses have been defined. 62 refs.; 11 figs.

48352 (JINR-E–2-88-363, pp. 90-100) **Two-photon physics at LEP.** Ginzburg, I.F. (AN SSSR, Novosibirsk (USSR). Inst. Matematiki); Serbo, V.G. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8712145–: 3. seminar on physics of e^+e^- interactions, Dubna (USSR), 8-9 Dec 1987). In *Proceedings of the seminar Physics of e^+e^- interactions.* Order Number DE89018001/JAW. Available from NTIS (US Sales Only), PC A06/MF A01 - OSTI; INIS.
The two-photon production of hadrons in e^+e^- collisions $e^+e^-\to e^+e^-h$ from which the $\gamma\gamma\to h$ cross sections are extracted is discussed. The common features of these processes are: hadrons move, as a rule, along e^+e^- beam axis, their total transverse momentum $K_{\text{perpendicular or perpendicular to}}$ is small; the total hadron energy is usually less than $\sqrt{S}/2$. Physical problems of soft processes, exotics, hard processes, semihard processes are considered. New possibilities of LEP, the most interesting and real are presented. 21 refs.; 5 figs.

48353 (JINR-E–2-88-363, pp. 25-32) **Check of colour symmetry at the LEP collider.** Efremov, A.V. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8712145–: 3. seminar on physics of e^+e^- interactions, Dubna (USSR), 8-9 Dec 1987). In *Proceedings of the seminar Physics of e^+e^- interactions.* Order Number DE89018001/JAW. Available from NTIS (US Sales Only), PC A06/MF A01 - OSTI; INIS.
Experimental check of the detailed investigation of the hypothesis of spontaneous broken colour symmetry due to mixing of electromagnetic and strong interactions in the standard $(U)1xSU(3)_c xSU(2)_L$ model is made at the LEP collider in the process $e^+e^-\to e^+e^-$+2 jets. 19 refs.; 9 figs.

48354 (JINR-E–2-88-363, pp. 74-89) **Characteristics of hadron production in e^+e^- annihilation at LEP energy in the frame of the Luna Monte Carlo fragmentation model.** Batyunya, B.V. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8712145–: 3. seminar on physics of e^+e^- interactions, Dubna (USSR), 8-9 Dec 1987). In *Proceedings of the seminar Physics of*

e^+e^- interactions. Order Number DE89018001/JAW. Available from NTIS (US Sales Only), PC A06/MF A01 - OSTI; INIS.

The inclusive characteristics of the e^+e^--annihilation process at LEP energy, generated in the Monte-Carlo LUND model, have been obtained. The question on the choice of the model parameters, determining the rates of 2-,3- and 4-jet events, is discussed. The comparison of the generated event characteristics with the experimental ones obtained at lower energy points to the necessity of a more exact choice of the model parameters determining relative probability of different type hadron production. At the same time the properties of the momentum variable distributions of the generated particles reflect a general experimental picture at lower energy. 13 refs.; 7 figs.; 7 tabs.

48355 (JINR-E–2-88-363, pp. 101-109) **Polarization in tau-lepton production at LEP and $\sin^2\Theta_W$.** Riemann, T. (Akademie der Wissenschaften der DDR, Berlin-Zeuthen (German Democratic Republic). Inst. fuer Hochenergiephysik); Sachwitz, M. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8712145–: 3. seminar on physics of e^+e^- interactions, Dubna (USSR), 8-9 Dec 1987). In *Proceedings of the seminar Physics of e^+e^- interactions.* Order Number DE89018001/JAW. Available from NTIS (US Sales Only), PC A06/MF A01 - OSTI; INIS.

Polarization measurements in tau lepton production in e^+e^-->γ,Z->$f^+f^-(\gamma)$ interaction at LEP are performed.These calculations include besides the Born cross-section the inclusive one-photon production as is indicated. They are based on analytic results obtained at Dubna. The slightly extended version of the Fortran code BREMU 87 which has been used for the investigations presented here is BRETAU 87. The tau-polarization may be calculated by a slight modification of cross-sections for helicity-averaged production. 11 refs.; 4 figs.

48356 (Juel-Spez–494) **A consistent meson-theoretical model of the nucleon-antinucleon interaction.** Hippchen, T. Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Kernphysik; Bonn Univ. (Germany, F.R.). Mar 1989. 181p. (In German). Order Number DE90702846/JAW. Available from NTIS (US Sales Only), PC A09/MF A01.

A meson exchange model is presented for the N-anti N interaction. The elastic part is taken to be the G-parity transform of the recent Bonn N-N potential, which beyond traditional one-boson-exchange diagrams also takes into account explicit 2π- and πrho-exchange processes as well as virtual Δ-exitations. It is defined in terms of meson exchange over the whole range, i.e. no ad hoc parametrization of the inner part has to be introduced. In a first step, a phenomenological, complex optical potential V_{opt} has been added in order to globally account for N-anti N annihilation. The simple N-anti N model leads already to a good reproduction of the low- and medium-energy N-anti N data. In the next step, a theoretical annihilation model has been derived from nucleon, delta and hyperon (Λ, Σ, Y^*) exchange diagrams with 2-meson final states involving π, rho, σ, δ, ω, K and K^* mesons. The corresponding meson-baryon couplings are chosen consistently with former studies of the N-N and hyperon-nucleon system. Based on this microscopic annihilation model, again using the G-parity transform of the Bonn potential as elastic part, the anti p-p elastic as well as total cross section data can be reproduced quantitatively, together with a shoulder in the rho-parameter at low energies, suggested by experiment. In contrast to the phenomenological annihilation model, the theoretical model predicts several bound states with relatively narrow widths ($\Gamma \leq 30$ Mev). (orig.).

48357 (SLAC-PUB–5057) **Neutrinos beyond the Standard Model.** Valle, J.W.F. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Aug 1989. 23p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (FTUV–89-26;CONF-8905187–2: WEIN '89: international symposium on weak and electromagnetic interactions in nuclei, Montreal (Canada), 15-19 May 1989). Order Number DE89015641/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

I review some basic aspects of neutrino physics beyond the Standard Model such as neutrino mixing and neutrino non-orthogonality, universality and CP violation in the lepton sector, total lepton number and lepton flavor violation, etc.. These may lead to neutrino decays and oscillations, exotic weak decay processes, neutrinoless double β decay, etc.. Particle physics models are discussed where some of these processes can be sizable even in the absence of measurable neutrino masses. These may also substantially affect the propagation properties of solar and astrophysical neutrinos. 39 refs., 4 figs.

48358 **Dirac neutrino masses as two-loop radiative corrections.** Babu, K.S. (Maryland Univ., College Park, MD (USA). Dept. of Physics); He, X.G. *Modern Physics Letters A (USA),* 4(1): 61-70 (1989).

The authors present a left-right symmetric model in which small and finite Dirac neutrino masses are generated as two-loop radiative corrections. Typical masses of the order 10^{-2} eV, 1 eV and 10^2 are obtained for ν_e, ν_μ and ν_{tau}, respectively. The model also features a generalized seesaw mechanism for the charged fermions which is achieved by the inclusion of heavy charged singlet fermions.

48359 **Falling antimatter: An experiment to measure the gravitational acceleration of the antiproton.** Dyer, P. (Los Alamos National Lab. (LANL), NM (USA). Physics Div.); Camp, J.; Holzscheiter, M.H.; Graessle, S. *Nuclear Instruments and Methods in Physics Research, Section B: Beam Interactions with Materials and Atoms (Netherlands),* 40/41(pt.1): 485-488 (Apr 1989). (CONF-881151–: 10. international conference on the application of accelerators in research and industry, Denton, TX (USA), 7-9 Nov 1988).

According to some theories of gravity, antimatter will fall faster than matter in the earth's gravitational field. An experiment to measure the gravitational force on the antiproton is under construction. Antiprotons of a few MeV from the LEAR facility of CERN will be slowed down and caught in a large Penning electromagnetic trap. They will then be cooled and transferred to Penning cooling and launching traps. The gravitational acceleration will be measured by time of flight in a drift tube shielding stray electric fields, and will be compared with that measured for H^- ions. Progress on a number of fronts is described. (orig.).

48360 **Spin correlation effects in the hadroproduction and decay of very heavy top quark pairs.** Barger, V. (Wisconsin Univ., Madison, WI (USA). Dept. of Physics); Ohnemus, J.; Phillips, R.J.N. *International Journal of Modern Physics A (USA),* 4(3): 617-626 (1989).

Density matrix techniques in the helicity basis allow to write down explicitly the squared matrix elements for tree-level hadroproduction and weak decay of very heavy top quark pairs, that decay before hadronization. This treatment includes the full effects of quark spin correlation. The effects of spin correlation are quantitatively small compared to calculations that ignore them, giving corrections of order 10% or less in the physical distributions studied.

6453 Particle Invariance Principles and Symmetries

Refer also to citation(s) 48422, 48423

48361 (INIS-mf–11514, pp. 449-466) **Supersymmetric flavor and CP violation.** Hall, L.J. (Harvard Univ., Cambridge, MA (USA). Lyman Lab. of Physics). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

The flavor and CP properties of the supersymmetric standard SU(3) x SU(2) x U(1) model (SSM) are briefly reviewed and several important results are stated. A new mechanism for flavor and CP violation is discussed. It is interesting and important since it occurs whenever the SSM is embedded in a larger scheme. B^0-B^{-0} mixing and B->(hard γ+x) are good places to search for such nonstandard flavor violations. A new scheme for CP violation in supersymmetric models is sketched. 10 refs., 10 figs. (author).

48362 (INIS-mf–11514, pp. 643-654) **E_8 symmetry breaking in the superstring theory.** Ovrut, B.A. (Pennsylvania Univ., Philadelphia, PA (USA). Dept. of Physics). Warsaw Univ. (Poland).

Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

We derive two methods for determining the symmetry breaking of E_6 in the low energy superstring theory, and classify all breaking patterns. A method for calculating the effective Higgs vacuum expectation values is presented. We show that there are theories with naturally light SU_2^W Higgs doublets and classify all theories in which this occurs. 12 refs., 2 tabs. (author).

48363 (KEK–88-12, pp. 32-54) **Application of superconformal symmetry to string compactification.** Eguchi, Tohru (Tokyo Univ. (Japan). Dept. of Physics); Ooguri, Hirosi; Taormina, A.; Yang, Sung-Kil. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

We discuss string compactifications on manifolds with SU(n) holonomy by making use of representation theories of extended superconformal algebras. In particular string compactification on K_3 surfaces is discussed in detail. We calculate loop space indices and show that all c = 6 superconformal field theories describe string propagation on manifolds with SU(2) holonomy. We also discuss c = 9 superconformal field theories and their relation to Calabi-Yau manifolds. (author).

48364 (KEK–88-12, pp. 72-93) **Realistic superstring models. An introduction.** Matsuoka, Takeo (Nagoya Univ. (Japan). Dept. of Physics). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

Realistic models from the heterotic superstring theory are reviewed briefly. Special attention is paid to the discrete symmetries linked to the topological and geometrical structure of the Calabi-Yau compacified manifold. The relation between the geometrical approach and the algebraic approach is also discussed. (author).

48365 (KEK–88-12, pp. 132-141) **Renormalization group flow and string dynamics.** Soda, Jiro (Hiroshima Univ., Takehara (Japan). Research Inst. for Theoretical Physics). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

The renormalization group flow in the nonlinear sigma model approach is explicitly solved up to fourth order in the case of an open string propagating in the tachyon background. We show that its fixed point solution produces the tree-level 5-point tachyon amplitude. Furthermore this argument is extended to all orders. (author).

48366 (KEK–88-12, pp. 154-172) **E_7 type modular invariant Wess-Zumino theory and Gepner's string compactification.** Kato, Akishi (Tokyo Univ. (Japan). Dept. of Physics); Kitazawa, Yoshihisa. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

The report addresses the development of a general procedure to study the structure of operator algebra in off-diagonal modular invariant theories. An effort is made to carry out this procedure in E_7 type modular invariant Wess-Zumino-Witten theory and explicitly check the closure of operator product algebra, which is required for any consistent conformal field theory. The conformal field theory is utilized to construct perturbative vacuum in string theory. Apparently quite nontrivial vacuums can be constructed out of minimal models of the N = 2 superconformal theory. Here, an investigation made of the Yukawa couplings of such a model which uses E_7 type off-diagonal modular invariance. Phenomenological properties of this model is also discussed. Although off-diagonal modular invariant theories are rather special, realistic models seem to require very special manifolds. Therefore they may enhance the viability of string theory to describe real world. A study is also made on Verlinde's fusion algebra in E_7 modular invariant theory. It is determined in the holomorphic sector only. Furthermore the indicator is given by the modular transformation matrix. A pair of operators which operate on the characters play a crucial role in this theory. (Nogami, K.).

48367 (KEK–88-12, pp. 110-118) **Four dimensional open superstring model.** Ishibashi, Nobuyuki (Tokyo Univ. (Japan). Dept. of Physics); Onogi, Tetsuya. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

The active studies of superstring theory in recent years began with the discovery of the anomaly and infinity cancellation of SO(32) type I superstring theory. Since then, numerous superstring models are constructed and the natures of multi-loop amplitudes are investigated. However, all these developments have been made mainly for the heterotic type string theories which consist of closed strings only. Type I superstring theories, which consist of open and closed strings, have not been studied so actively. The biggest reason for this is that it is very difficult to construct four dimensional models with chiral fermions by compactifying the type I theory. This note considers four dimensional superstring models compactified on Z_N orbifolds in general. A study is made to construct such a model explicitly in Z_3 case and show that it is a model which contains three generations of chiral fermions. The open string models considered here are unoriented ones. The nonorientability of the models makes it possible for the divergences of the annulus and the Moebius strip amplitudes to cancel. The closed string sectors of such unoriented models are also unoriented. (Nogami, K.).

48368 (KEK–88-12, pp. 142-153) **Interacting models on the torus.** Kimura, Kazuhiro (Kobe Univ. (Japan). Dept. of Physics). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

We formulate the U(N)WZW model constructed vertex operators on the torus. This formulation corresponds to the chiral bosonization . We give the 2n-point correlation function in this formulation. (author).

48369 (KEK–88-12, pp. 173-182) **Covariant operator formalism of bosonic string theory.** Konno, Hitoshi (Tsukuba Univ., Ibaraki (Japan). Inst. of Physics). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

Covariant operator formalism of bosonic string theory based on the BRST symmetry is introduced. The duality of the ghost string vertex is explored and recovered in the N ghost string vertex. Duality guarantees that any amplitudes are reduced to the combination of a few primitive operators. We demonstrate this point in the planar case, showing the construction of the multi-loop operator from a set of one-loop tadpole operators. The result has a correct measure due to the ghost contribution. (author).

48370 (KEK–88-12, pp. 293-301) **One-loop dynamics of four-dimensional string theory.** Senda, Ikuo (Tokyo Inst. of Tech. (Japan)). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number

DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

The report discusses the dynamical aspects of four-dimensional string theory as compared with the field theory. These investigations are important to connect the string theory with phenomena in the energy scale concerned. One of the severest difficulties in string theory is the fact that the string theory is formulated in the critical dimensions, namely 10 and 26 for superstring and bosonic string, respectively. Some problems in four-dimensional superstring theory and the answers obtained are summarized. The answers are as follows. It is possible to obtain renormalization group equations (RGEs). For the RGEs of supersymmetric (N=1) theory, beta functions are shown to be the same as those of the corresponding field theory. As for the model investigated here (N=1 supersymmetric orbifold compactification of heterotic string), the structures of internal spaces appear in two ways. The structure of six-dimensional orbifold is reflected in amplitudes through the zero modes of one-loop propagators of the twisted fields and that of sixteen-dimensional internal space through the indices of the representations to which massless states of the theory belong. It is possible to investigate symmetry breakings. One can encounter Fayet-Illiopoulis model like situations in supersymmetric models. One can obtain one-loop effective potential of massless scalar bosons and discuss the possibilities of symmetry breakings. (Nogami, K.).

48371 (KEK–88-12, pp. 244-251) **Evaluation of one-loop mass shifts in open superstring theory.** Tsuchiya, Akihiko (Tokyo Inst. of Tech. (Japan)). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

All integral expressions of two-point functions presented in literature are divergent even after eliminating dilation tadpole divergences by the well-known Green-Schwarz' procedure. A transition matrix obtained from an one-loop two-point amplitude must have an imaginary part required from unitarity, but the standard method to calculate on-shell string amplitudes does not give such an imaginary part. It is expected that the on-shell two-point function thus calculated is on a cut as a function of external momentum and therefore, proper analytic continuation would be needed to extract correct answer from it. In this process, one would gain the imaginary part of the mass shift, which is also expected to give the damping factor of lifetime of the massive mode and express its instability. The author has been engaged in studies aming to estimate correct values of mass shifts of the bosons of first and second mass levels in type I superstring theory at one-loop level. In particular, the present study focuses on evaluating the value of mass shift at the first excited level. A two-point function at a given mass level is a complex value, not a function of external momentum. So it can give a touchstone to see whether ordinary string perturbation expansion is a sensible one, by comparing the order of the values of loop effect to those of tree part. (Nogami, K.).

48372 (KEK–88-12, pp. 223-232) **On bosonization in BC system.** Takama, Michiaki (Kobe Univ. (Japan)). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (In Japanese). (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

A BC system follows the first order lagrangian based on the superconformal ghost which appears in BRST quantization in the superstring theory. It consists of a Grassmann-even superfield, B, with a superconformal weight of λ-1/2 and a Grassmann-odd superfield, C, with a superconformal weight of 1-λ. With respect to its components, a BC system consists of a fermion-ghost pair (b, c) and boson-ghost pair (β,γ), which are unified through supersymmetry. Thus, the bosonization is a BC system has conventionally been treated in terms of these two different pairs. Essentially, however, a BC system must be represented in such a supersymmetric form as (1,1). Super-Riemannian surfaces have to be considered in formulating the superstring theory. In general, therefore, non-split super-Riemannian surfaces have to be taken into account in performing superconformal transformation, and clear supersymmetry is important in considering a system on such non-split super-Riemannian surfaces. It is demonstrated here that there exists such bosonization (referred to as super-bosonization). In super-bosonization, a BC system is re-constructed by using vertex operators in two conjugate scalar super-fields connected with background charges. (Nogami, K.).

48373 (KEK–88-12, pp. 284-292) **Lorentz symmetry in the light-cone field theory of open and closed strings.** Saitoh, Yoshihiro (Tokyo Inst. of Tech. (Japan). Dept. of Physics); Tanii, Yoshiaki. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

In this report, the authors will examine the Lorentz covariance of the light-cone SFT for the open-closed mixed system. It will be considered the 26-dimensional orientable bosonic string theory. The authors propose a transformation law of the string fields with undetermined coefficients using the vertices appearing in the action. These coefficients are fixed up to one unfixed constant requiring the invariance of the action and the closure of the algebra as much as possible. However, with any choice of this last constant, the invariance of the action and the closure of the algebra are not completely achieved at the classical level due to three diagrams which contain closed string intermediate states. (author).

48374 (KEK–88-12, pp. 210-222) **BRS formulation of bosonic string theory and the properties of non-critical strings.** Suzuki, Hiroshi (Hiroshima Univ., Takehara (Japan). Research Inst. for Theoretical Physics). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

We review our recent study of a construction of covariant tensorial (BRS, energy-momentum, and ghost number) operators for bosonic string theory in the conformal approach. By incorporating the 2-dimensional world-sheet metric freedom explicitly in the theory, it is shown that these covariances are maintained for an arbitrary space-time dimension D. After this construction we examine the covariant quantization of the metric freedom. We find an interesting solution at $D < 26$, which maintains the above covariance and also the closure of the BRS symmetry. Using a string field theoretical technique, we investigate the physical spectrum of this non-critical string. We find that the 2-dimensional gauge symmetry realizes itself as the Higgs mechanism in D-dimensional space-time. We discuss briefly the implications of our results on the quantization of interacting non-critical strings. (author).

48375 (KEK–88-12, pp. 233-243) **One-particle-irreducible effective Lagrangian of string modes.** Watabiki, Yoshiyuki (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

We propose a new method to obtain the effective Lagrangian from the vanishing of β-functions. Although the β-functions are not one-particle-irreducible at more than five-string interaction level, we can rewrite them in a one-particle-irreducible form by redefining the background fields. The vanishing of the β-functions is then considered as the equations of motion of the modified background fields.(author).

48376 (KEK–88-12, pp. 263-273) **Pre-geometrical field theory of open string.** Nojiri, Shin-ichi (Kyoto Univ. (Japan). Dept. of Physics). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number

DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

We propose a gauge invariant, background independent string action, which contains open and closed string fields and no kinetic terms. The kinetic term is generated through the condensation of the string fields, which is the solution of equations of motion. We solve the equations and show that the action is classically equivalent to the open string action proposed by Hata et al. (author).

48377 (KEK–88-12, pp. 274-283) **Off-shell amplitude in Witten's bosonic string field theory.** Sakai, Kenji (Hiroshima Univ., Takehara (Japan). Research Inst. for Theoretical Physics). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

The off-shell amplitude are calculated in the Witten's bosonic string field theory. We use ordinary methods in the first quantization by extending the Giddings' approach to this theory. (author).

48378 (KEK–88-12, pp. 334-345) **Zero mode and modular invariance in string on non-abelian orbifold.** Nima, Shuji (Kyushu Univ., Fukuoka (Japan). Dept. of Physics). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

The report discusses the operator formalism of the zero mode part of closed bosonic string on orbifold. The dividing group of orbifold treated in this report may be non-abelian and have invariant subspace. The orbifold dealt with here is the quotient space T^d/G. T^d is the d-dimensional torus. T^d is described by the identification of X^I and $X^I + \pi L^I$ on flat space where L^I is a point on a lattice Λ. G is a symmetry of Λ. The plan for treating the zero mode part of the string on orbifold ($=T^d/G$) is as follows. The Hilbert space of a dynamical system on T^d is first constructed to express the quantum theory on orbifold. This Hilbert space is a direct sum of the Hilbert space of some constrained systems and each constraint is connected with each boundary condition of string. Next, this Hilbert space is projected into the subspace invariant under G-transformation. In particular, the present report concentrates on the construction of the Hilbert space of the above-mentioned constrained system, and briefly discusses the one-loop vacuum amplitude and its modular invariance. (N.K.).

48379 (KEK–88-12, pp. 313-322) **Classifications of Z_N orbifold models.** Kobayashi, Tatsuo (Kanazawa Univ. (Japan). Dept. of Physics). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

The present study aims to classify Z_4, Z_6 and Z_7 orbifold models systematically. The discussion on the Z_N orbifold is started with the $E_8 \times E_8$ heterotic string in the bosonized form. That is the theory with 10-dimensional supersymmetric right movers and 26-dimensional bosonic left movers. The Z_N orbifold is obtained with the division of a 6-dimensional torus by a discrete rotation, or R^6 by a space group S, which consists of discrete rotations θ and discrete translations e^a, where θ should be automorphism of a lattice spanned by e's. With this division, the SO(8) weight lattice and the $E_8 \times E_8$ lattice must be modeled, i.e. the discrete rotation θ is associated with shifts v^I and V^I on the SO(8) weight lattice and the $E_8 \times E_8$ lattice, respectively, so that one can get a model with N = 1space-time supersymmetry, smaller gauge group and some matters. Finally, ten Z_4 models, fifty four Z_6-I ones, fifty six Z_6-II ones and thirty nine Z_7 ones are obtained, though the given models are still realistic, i.e. they have large gauge groups and many matters. To get a more realistic model from given models, some mechanisms as well as orbifold models are needed. Further, Z_8 and Z_{12} orbifold models can be given by the same construction as proposed here. (N.K.).

48380 (KEK–88-12, pp. 323-333) **Superpotential in Calabi-Yau compactification.** Suematsu, Daijiro (Kanazawa Univ. (Japan). Dept. of Physics). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

We study the structure of superpotential by relating Calabi-Yau compactification to the string construction with the tensor product of N = 2 superconformal field theory. In the case of 4-generation Y (4;5) Calabi-Yau manifold we completely calculate the generation dependent Yukawa coupling constants in the base of physical quarks and leptons. Proton decay mediating coupling can not be zero in this model. (author).

48381 **Status of the $\Delta I = 1/2$ rule in Kaon decay.** Cheng, H.Y. (Indiana Univ., Bloomington, IN (USA). Dept. of Physics). *International Journal of Modern Physics A (USA),* 4(3): 495-582 (1989).

The $\Delta I = 1/2$ rule in $K \to \pi\pi$ decays and its status are discussed and reviewed. First, the authors present the phenomenological deductions which have a firm basis, including the penguin diagram, vacuum insertion, current algebra and chiral perturbation theory. Then they proceed to discuss new conjectures and speculations e.g. I/N expansion, W-exchange, low-energy penguin diagrams, the s-d self-energy tadpole, QCD-quality, instanton effects, etc. and to assess their roles in understanding the $\Delta I = 1/2$ enigma.

48382 **Triviality of the Higgs field.** Huang, K. (Massachusetts Inst. of Tech., Cambridge, MA (USA). Center for Theoretical Physics). *International Journal of Modern Physics A (USA),* 4(5): 1037-1054 (1989).

The authors give a critical review of the triviality of the λphi theory, i.e., the vanishing of the renormalized self-coupling. Evidence from perturbation theory and Monte-Carlo simulations are cited. It is noted that (a) the theory is trivial but not entirely free, for there is spontaneous symmetry breaking; (b) perturbation theory is unreliable. Soluble examples with similar behavior are compared, in particular the Lee model and the 3D δfunction potential. The latter case is especially important, for it shows that triviality is a symptom that the interaction is too singular, and suggests a cure. The import for the Higgs sector of the standard model is discussed. It is argued that, like the Fermi pseudopotential, the Higgs field is a long-wavelength approximation that should be used in lowest order perturbation theory only.

48383 **Superconformal symmetry and superstring compactification.** Schwarz, J.H. (California Inst. of Tech., Pasadena, CA (USA)). *International Journal of Modern Physics A (USA),* 4(11): 2653-2714 (1989).

Various topics in conformal field theory and the theory of Kac-Moody algebras are presented. In particular, the Goddard-Kent-Olive construction is used to derive various conformal and superconformal theories, including a large class of N = 2 models recently discovered by Kazama and Suzuki, The relationship between compactification of extra dimensions and the description of internal degrees of freedom by a conformal field theory is discussed. Various approaches to compactification based on exactly soluble conformal field theories, including Gepner's proposal for using the N = 2 minimal models, are sketched. Recent progress in understanding N = 2 models and Calabi-Yau spaces using mathematical techniques of singularity theory is described. It is argued that a classical solution could be a useful first approximation to a quantum ground state even though it is known that string theory is strongly coupled and the perturbation expansion diverges.

48384 **The canonical structure of the manifestly supersymmetric string.** Allen, T.J. (California Inst. of Tech., Pasadena, CA (USA)). *International Journal of Modern Physics A (USA),* 4(11): 2811-2826 (1989).

Both the Green-Schwarz and Siegel strings are presented in canonical form. Both systems are shown to describe the same number of physical degrees of freedom. The apparent extra symmetries of the Seigel string are not true symmetries but are combinations of second-class constraints. A formal quantization procedure is outlined and the problems of quantization are discussed.

6454 Field Theory

Refer also to citation(s) 48329, 48333, 48381, 48383, 48540, 48564

48385 (CONF-8902132–1) **Bordered surfaces, off-shell amplitudes, sewing, and string field theory.** Carlip, S. Institute for Advanced Study, Princeton, NJ (USA). Apr 1989. 43p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76ER02220. (IASSNS-HEP–89/29). From 25. Karpacz winter school of theoretical physics; Karpacz (Poland); 20 Feb - 5 mar 1989. Order Number DE90000006/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

These lectures will deal with the current status of the sewing problem. The rationale for this approach is that any nonperturbative string theory must reproduce the Polyakov path integral as a perturbation series. If our experience in ordinary field theory is a guide — and admittedly it may not be — the terms in such a perturbation series, like Feynman diagrams, are likely to be built up from simple "vertices" and "propagators," which can themselves be represented as (off-shell) Polyakov amplitudes. Hence an understanding of how to put together simple components into more complicated world sheet amplitudes is likely to give us much-needed information about the structure of nonperturbative string theory. To understand sewing, we must first understand the building blocks, off-shell Polyakov amplitudes. This is the subject of my first lecture. Next, we will explore the sewing of conformal field theories at a fixed conformal structure, that is, the reconstruction of correlation functions for a fixed surface Σ from those on a pair of surfaces Σ_1 and Σ_2 obtained by cutting Σ along a closed curve. We will then look at the problem of sewing amplitudes, integrals of correlation functions over moduli space. This will necessitate an understanding of how to build the moduli space of a complicated surface from simpler moduli spaces. Finally, we will briefly examine vertices and string field theories. 48 refs., 10 figs.

48386 (IC–88/418) **Simple proof of renormalization group equation in the minimal subtraction scheme.** Chetyrkin, K.G. International Centre for Theoretical Physics, Trieste (Italy). Apr 1989. 18p. Order Number DE90600758/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

We give a simple combinatorial proof of the renormalization group equation in the minimal subtraction scheme. Being mathematically rigorous, the proof avoids both the notorious complexity of techniques using parametric representations of Feynman diagrams and heuristic arguments of usual "proofs" calling up bare fields living in the space-time of complex dimension. It also copes easily with the general case of Green functions of arbitrary number of composite fields. (author). 24 refs.

48387 (IC–89/41) **Tachyons in N=2 superconformal models and topological instability of defining the polynomial of Calabi-Yau manifolds.** Kei Ito. International Centre for Theoretical Physics, Trieste (Italy). Apr 1989. 7p. Order Number DE90600765/JAW. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS.

We study the relationship between tachyons in N=2 superconformal tensor product models and topology changing of the defining polynomial of corresponding algebraic varieties. We show that monomials which correspond to tachyons change topology of the defining polynomial if they are added whereas those corresponding to massless and massive fields do not. (author). 7 refs.

48388 (IC–89/90) **Sigma models and renormalization of string loops.** Tseytlin, A.A. International Centre for Theoretical Physics, Trieste (Italy). May 1989. 64p. Order Number DE90600766/JAW. Available from NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS.

An extension of the "σ-model β-functions - string equations of motion" correspondence to the string loop level is discussed. Special emphasis is made on how the renormalization group acts in string loops and, in particular, on the renormalizability property of the generating functional Z-circumflex for string amplitudes (related to the σ model partition function integrated over moduli). Renormalization of Z-circumflex at one and two loop order is analyzed in some detail. We also discuss an approach to renormalization based on operators of insertion of topological fixtures. (author). 70 refs.

48389 (IC–89/98) **Classification of modular invariant partition functions for the twisted N=2 superconformal algebra, twisted SU(2) Kac-Moody algebra and D_{2K} parafermions.** Dobrev, V.K.; Ganchev, A.H. International Centre for Theoretical Physics, Trieste (Italy). May 1989. 17p. Order Number DE90600767/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

The characters of the twisted n=2 super-Virasoro algebra (or equivalently - the twisted su(2) Kac-Moody algebra) and the closely related characters for the twisted sector of the parafermion algebra are represented in terms of order N Θ-constants with characteristics. All modular invariants for order N Θ-functions with characteristics are characterized by δ—N such that either δ or N/δ is odd. The modular invariant Z_2 orbifold partition functions for theories with c=3k/(k+2) are found and classified in an A-D-E series. (author). 35 refs.

48390 (IC–89/112) **On the domain of string perturbation theory.** Davis, S. International Centre for Theoretical Physics, Trieste (Italy). Jun 1989. 19p. Order Number DE90600759/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

For a large class of effectively closed surfaces, it is shown that the only divergences in string scattering amplitudes at each order in perturbation theory are those associated with the coincidence of vertex operators and the boundary of moduli space. This class includes all closed surfaces of finite genus, and infinite-genus surfaces which can be uniformized by a group of Schottky type. While the computation is done explicitly for bosonic strings in their ground states, it can also be extended to excited states and to superstrings. The properties of these amplitudes lead to a definition of the domain of perturbation theory as the set of effectively closed surfaces. The implications of the restriction to effectively closed surfaces on the behavior of the perturbation series are discussed. (author). 20 refs, 6 figs.

48391 (IC–89/114) **Production of photons in anisotropic spacetimes.** Lotze, K.H. International Centre for Theoretical Physics, Trieste (Italy). Jun 1989. 17p. Order Number DE90600760/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Under the main aspect of the creation of photon pairs from vacuum we investigate the Maxwell equations in anisotropic universes with a diagonal Bianchi type I metric. Thereby we employ a method developed earlier by Sagnotti and Zwiebach (1981). For two axisymmetric expansion laws we obtain exact photon solutions of the Maxwell equations making use of a WKB particle concept. We compute the number densities of created photons and emphasize the importance of singularity avoidance for getting finite results. In the case of weak anisotropies the results by Zel'dovich, and Starobinsky (1977) are regained and commented on. (author). 16 refs.

48392 (IC–89/127) **Stress-tensor commutators and Schwinger terms in singleton theories.** Bergshoeff, E.; Sezgin, E.; Tanii, Y. International Centre for Theoretical Physics, Trieste (Italy). Jun 1989. 17p. Order Number DE90600761/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

We compute the commutators of the regularized quantum stress-tensor of singleton theories formulated on the boundary of a (p + 2)-dimensional anti de Sitter space (AdS_{p+2}). (These are superconformal field theories on $S^p \times S^1$). We find that the algebra is not closed except in the case of AdS_3. It does contain, however, the finite dimensional AdS_{p+2} algebra SO(p + 1,2). We also find divergent, field dependent as well as field independent Schwinger terms (i.e. the central extensions), which, however, do not lead to anomalies in the algebra of the AdS charges. We also give a simple derivation of the two-point functions for bosonic and fermionic singletons. (author). 15 refs.

48393 (IC–89/128) **Casimir force between two Aharonov-Bohm selenoids.** Duru, I.H. International Centre for Theoretical Physics, Trieste (Italy). Jun 1989. 10p. Order Number DE90600762/JAW. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS.

We show that a force of Casimir type case be associated with the Aharonov-Bohm effect. We consider two parallel, infinitely long and thin selenoids confining the quantized fluxes n_1 and n_2 within them. Using the Green function method, the vacuum expectation value of the system's energy which includes "self interaction" terms and a finite "mutual interaction" term is calculated. 8 refs.

48394 (IC–89/129) **Milnor monodromy of singularities and chiral primary fields of N=2 superconformal field theories.** Kei Ito. International Centre for Theoretical Physics, Trieste (Italy). Jun 1989. 9p. Order Number DE90600763/JAW. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS.

Relation between chiral primary fields of an N=2 superconformal model and Milnor monodromy of the corresponding target space singularity is investigated. It is shown that conformal weights of chiral primary fields are identical to one half the difference between spectral numbers and the smallest spectral number. (author). 12 refs.

48395 (IC–89/154) **Electron-positron system at short distances.** Barut, A.O. International Centre for Theoretical Physics, Trieste (Italy). Jun 1989. 7p. Order Number DE90600764/JAW. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS.

In answer to a recent paper we discuss the application of a relativistic two-body equation and its mass-conjugate first to ortho-and para-positronium and then its extrapolation to short distances where self energy terms dominate leading to a phase transition in QED and possible new (e^+e^-)-resonances. (author). 15 refs.

48396 (INIS-mf–11514, pp. 201-215) **Critical questions concerning light cone formulation and possible renormalization of Yang-Mills theories.** Bassetto, A. (Padua Univ. (Italy). Ist. di Fisica). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

A correct and unambiguous formulation of Yang-Mills theories in the light-cone gauge is available both in the four and in the two component formulations. Renormalization is feasible at the one loop level, whereas the inductive proof at any order is still missing. 12 refs. (M.F.W.).

48397 (INIS-mf–11514, pp. 217-228) **Optimized perturbation series for the effective potential in PHI^4 field theory.** Okopinska, A. (Institute of Physics, Warsaw University Branch, Bialystok, (Poland)). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

A non standard method of perturbation expansion in QFT is presented, in particular self-interacting real scalar field (λPHI) in N dimensional Euclidean space. The method is formulated in path integral approach and can be easily generalized for other theories, even at finite temperature. 7 refs., 2 figs. (author).

48398 (INIS-mf–11514, pp. 229-238) **Hidden local symmetries from flavour anomalies of QCD.** Balog, J. (Eoetvoes Lorand Tudomanyegyetem, Budapest (Hungary)); Vecsernyes, P. Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

Making use of the generating functional of the non-Abelian flavour anomalies of QCD we construct a gauge invariant phenomenological Lagrangian of pseudoscalar and vector mesons, which is equivalent to the extended Wess-Zumino Lagrangian in the low energy approximation. The gauge kinetic term of the hidden local symmetry is necessarily present and the gauge coupling constant is determined by the equivalence. 15 refs., 1 tab. (author).

48399 (INIS-mf–11514, pp. 239-255) **Present status of the bag model - a cursory review.** Baacke, J. (Dortmund Univ. (Germany, F.R.). Inst. fuer Physik). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

A review of the present status of the MIT bag model is given. The some comments pertaining to the following questions are presented: Which are the essential features of the bag model? What can we learn from the model about the consequences of confinement? What are the open problems? 45 refs. (M.F.W.).

48400 (INIS-mf–11514, pp. 271-280) **Regular lattices as saddle-points of a two dimensional random lattice theory.** Pertermann, D. (Leipzig Univ. (German Democratic Republic). Sektion Physik). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

A two dimensional random lattice theory with a free massless scalar field theory is considered. We analysed the field theoretic generating functional for any given choice of positions of the lattice sites. Asking for saddle-points of this generating functional with respect to the positions we found the hexagonal lattice and the triangulated version of the hypercubic lattice as candidates. 6 refs., 4 figs. (author).

48401 (INIS-mf–11514, pp. 359-373) **Anomalies in gauge and supersymmetric gauge theories.** Piquet, O. (Geneva Univ. (Switzerland). Inst. de Physique Theorique). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

Gauge anomalies are defined and recent applications to N = 1 rigid supersymmetric gauge theories are reviewed. 33 refs. (author).

48402 (INIS-mf–11514, pp. 397-406) **Superspace quantization of gauge theories: gauge-fixing and ghost terms in N=1 supergravity.** Hirshfeld, A.C. (Dortmund Univ. (Germany, F.R.). Inst. fuer Physik). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

The superspace quantization of supergravity is discussed. The gauge-fixing and ghost terms are produced simultaneously. Two examlpes are considered: N=1 supergravity and quantum Yang-Mills theory. In N=1 supergravity the Faddeev-Popov method is not applicable in its usual form, but the super-space quantization approach yields also in this case an exactly BRS-invariant Lagrangian. 18 refs. (M.F.W.).

48403 (INIS-mf–11514, pp. 617-632) **Magnetic monopoles in Kaluza-Klein theory.** Sundaresan, M.K. (Carleton Univ., Ottawa, ON (Canada). Dept. of Physics); Tanaka, K. Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

We start with an introduction to magnetic monopoles and then discuss the magnetic monopoles in 5-dimensions, the stability of solution with respect to small changes in the metric, and finally end with remarks. 15 refs. (author).

48404 (INIS-mf–11514, pp. 669-692) **Grand unification: quo vadis domine?.** Senjanovic, G. (Brookhaven National Lab., Upton, NY (USA)). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

An attempt is made to summarize the present theoretical and experimental situation with grand unification. 31 refs. (author).

48405 (INIS-mf–11515, pp. 124) **2D axial anomaly without ambiguity.** Embacher, G. (Innsbruck Univ. (Austria). Inst. fuer Theoretische Physik); Gruebl, G.; Oberguggenberger, M. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48406 (INIS-mf–11515, pp. 125) **Non-perturbative 2D axial-vector-current anomaly.** Embacher, H.G. (Innsbruck Univ. (Austria). Inst. fuer Theoretische Physik); Gruebl, G. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48407 (INIS-SU–113/A, pp. 41-43) **Action for a non-Archimedean string and Brua-Tits trees.** Zabrodin, A.V. AN SSSR, Moscow (USSR). Fizicheskij Inst. 1989. (In Russian). (T–23539). In *Experimental and theoretical physics. Collection.* Order Number DE89018003/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Kratkie soobshcheniya po fizike.; v. 1.

The Brua-Tits three is a natural analog of the world leaf in the theory of non-Archimedean strings. A model of field theory on the tree is plotted, which provides the Freund-Olson amplitudes for the processes of particle emission from the boundary of the world leaf. 3 refs.; 1 fig.

48408 (KEK–88-12) **Proceedings of the summer workshop on superstrings.** National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. 349p. Order Number DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

Individual papers are processed separately for the data base. (DLC)

48409 (KEK–88-12, pp. 18-31) **Representation theory of current algebra and conformal field theory on Riemann surfaces.** Yamada, Yasuhiko (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

We study conformal field theories with current algebra (WZW-model) on general Riemann surfaces based on the integrable representation theory of current algebra. The space of chiral conformal blocks defined as solutions of current and conformal Ward identities is shown to be finite dimensional and satisfies the factorization properties. (author).

48410 (KEK–88-12, pp. 55-71) **Introduction to W-algebras.** Takao, Masaru (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

We review W-algebras which are generated by stress tensor and primary fields. Associativity plays an important role in determining the extended algebra and further implies the algebras to exist for special values of central charges. Explicitly constructing the algebras including primary fields of spin less than 4, we investigate the closure structure of the Jacobi identity of the extended algebras. (author).

48411 (KEK–88-12, pp. 1-17) **Introduction to conformal field theories.** Kato, Akishi (Tokyo Univ. (Japan). Dept. of Physics). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

The report addresses how one can construct a 'complete' field theory in which any N point correlation functions can be calculated exactly. For this, one has to present a systematic way of calculating correlation functions. It is postulated that the set of local field operators is closed under the multiplicative structure known as operator product algebra (OPA). That means OPE holds as an exact relation. Then any N point function can be expressed in terms of N-1 point functions. Thus, one can calculate, in principle, any N point functions if one point functions and structure functions are know. But it must be guaranteed that the result does not depend on the way of applying OPA. This is the requirement of associativity of OPA, which is indispensable to construct consistent field theories. Bootstrap hypothesis says that the structure of OPA is determined solely by this consistency of the theory. The bootstrap condition puts infinite number of equations on the structure functions because one can think of correlation functions of arbitrary number of operators with arbitrary configurations. Conformal invariance implies that physical quantities are invariant under the local scale transformations, i.e. the scaling factor being different from point to point. In two dimensions, this invariance turns out to be infinite dimensional symmetry, and this 'gauge' symmetry is the master key to the miraculous solution of bootstrap problem. (Nogami, K.).

48412 (KEK–88-12, pp. 183-192) **Parametrization of super light-cone diagrams with g-loops.** Hamada, Kenji (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

We review the recent developments of the light-cone gauge formulation of fermionic string of Mandelstam. To formulate the fermionic string in a superspace, we use the theory of super Riemann surfaces (SRS). We define the Neumann functions and the Mandelstam mappings in a superspace by means of the so-called abelian differentials of the first and the third kinds on SRS. The functional integral measure of a super light-cone diagram, which consists of 6g - 6 + 2N even moduli parameters and 4g - 4 + 2N odd ones, are specified in our formulation. (author).

48413 (KEK–88-12, pp. 119-131) **Boundary and crosscap states in conformal field theories.** Ishibashi, Nobuyuki (Tokyo Univ. (Japan). Dept. of Physics); Onogi, Tetsuya. National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

The report presents the consistency condition in open string theory. The minimal models are studied and the operator contents of the theories are determined. One-loop amplitudes are given by the sum of the path integral over four two-dimensional surfaces: torus (T), Klein bottle (KB), annulus (A) and Moebius strip (MS). KB, A and MS amplitudes also represent the process in which closed string states appear from the vacuum and propagate for a certain time. One can calculate the amplitudes either by taking traces in the open and closed string states or by computing the tree-level transition amplitudes. These must give the same result, which implies that there exists a close relationship in the operator content (spectrum) of the open and the closed string sector. Given the gauge

group and the spectrum of the open string sector, the spectrum of the closed string sector can be determined completely. To define a finite amplitude from the T amplitude, the closed string sector must satisfy the modular invariance condition just as in closed string theories. The only missing point is how to determine the gauge group. The answer is the gauge anomaly cancellation conditions. In string theory anomalies appearing in the scattering amplitudes are reduced to the surface integral over the boundary of the moduli space. In the one-loop case, one can show that the possible source of the non-vanishing surface term is the tadpoles of massless fields. (Nogami, K.).

48414 (KEK–88-12, pp. 252-262) **Two dimensional conformal gauge theories.** Ichinose, Shoichi (University of Shizuoka (Japan). Dept. of Physics). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

The 2-dim quantum gauge theories are investigated in the approach of the conformal field theory. Some important points such as gauge fixing, the residual symmetry, physical quantities and the energy-momentum tensor are examined in detail. The renormalized gauge coupling constant is shown to be determined absolutely. Some obscure aspects of Polyakov et al's 2-dim quantum gravity are clarified from the standpoint of general gauge theories. (author).

48415 (KEK–88-12, pp. 302-312) **Reducing the rank of gauge groups in orbifold compactification.** Sato, Hikaru (Hyogo Univ. of Education, Yashiro (Japan). Dept. of Physics). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

The report introduces general twisted boundary conditions on fermionic string variables and shows that a non-Abelian embedding is possible when background gauge field is introduced on orbifold. This leads to reduction of the rank of the gauge group. The report presents a procedure to obtain the lower-rank gauge groups by the use of non-Abelian Wilson lines. The unbroken gauge group is essentially determined by the eigen vector which should obey the level-matching conditions. The gauge symmetry is determined by certain conditions. In a particular application, it is not necessary to introduce explicit form of the non-Abelian Wilson lines. The procedure starts with introduction of desired eigen vectors which are supposed to be obtained by diagonalization of the boundary conditions with the appropriate transformation matrix. The rank is reduced by one by using the Wilson lines which transform as 3 of $SU(2)_R$ or SU(2) in SU(4). A possible way of reducing the rank by two is to use the Wilson lines from $SU(2)_R$ x SU(2) or SU(3) in SU(4). The rank is reduced by three by means of the Wilson lines which transform as SU(4) or $SU(2)_R$ SU(3). Finally the rank is reduced by four when the Wilson lines with full symmetry of $SU(2)_R$ x SU(4) are used. The report tabulates the possible lower-rank gauge groups obtained by the proposed method. Massless fermions corresponding to the eigen vectors are also listed. (N.K.).

48416 (N–89-21633) **Surface energy from order parameter profile: At the QCD phase transition.** Frei, Z.; Patkos, A. Eoetvoes Lorand Tudomanyegyetem, Budapest (Hungary). Jan 1989. 7p. (NASA-CR–184890;NAS–1.26:184890;FERMILAB-PUB–89/47-A). Available from NTIS, PC A02/MF A01.

The order parameter profile between coexisting confined and plasma regions at the quantum chromodynamic (QCD) phase transition is constructed. The dimensionless combination of the surface energy (Sigma) and the correlation length (Zeta) is estimated to be Sigma Zeta 3 approximately equals 0.8.

48417 (N–89-21634) **New class of non-topological solitons.** Frieman, J.A.; Lynn, B.W. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jan 1989. 21p. (NASA-CR–184889;NAS–1.26:184889;FERMILAB-PUB–89/31-A). Available from NTIS, PC A03/MF A01.

A class of non-topological solitons was constructed in renormalizable scalar field theories with nonlinear self-interactions. For large charge Q, the soliton mass increases linearly with Q, i.e., the soliton mass density is approximately independent of charge. Such objects could be naturally produced in a phase transition in the early universe or in the decay of superconducting cosmic strings.

48418 (SLAC-PUB–5031) **Moduli spaces and topological quantum field theories.** Sonnenschein, J. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Jul 1989. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-8907140–1: 18. international conference on differential geometric methods in theoretical physics: physics and geometry, Tahoe City, CA (USA), 2-8 Jul 1989). Order Number DE89016943/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

We show how to construct a topological quantum field theory which corresponds to a given moduli space. This method is applied to several cases. In particular we discuss the moduli space of flat gauge connections over a Riemann surface which is related to the phase space of the Chern-Simons theory. The observables of these theories are derived. Geometrical properties are invoked to prove that the global invariants are not trivial. 14 refs., 3 tabs.

48419 (SLAC-PUB–5095) **General QED/QCD aspects of simple systems.** Telegdi, V.L.; Brodsky, S.J. Stanford Linear Accelerator Center, Menlo Park, CA (USA). Sep 1989. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC03-76SF00515. (CONF-8806406–1: Symposium on the hydrogen atom, Pisa (Italy), 30 Jun - 2 jul 1988). Order Number DE89016952/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This paper discusses the following topics: renormalization theory; the Kinoshita-Lee-Nauenberg theorem; the Yennie-Frautschi-Suura relation; scale invariance at large momentum transfer; scaling and scaling violation at large momentum transfers; low-energy theorem in Compton scattering; does the perturbation series in QED converge; renormalization of the weak angle Θ_W; the Nambu-Bethe-Salpeter (NBS) equation; the decay rate of $^3S_1$ positronium; radiative corrections to QCD Born cross section; and progress on the relativistic 2-body equation.

48420 **Nonlocal character of the Rastall model.** Bedford, D. (Univ. of Natal, Durban (South Africa)); Stapp, H.P. *Foundations of Physics (USA),* 19(4): 397-406 (Apr 1989). DOE Contract AC03-76SF00098.

The discussion of whether quantum theory is compatible with the locality idea that no casual influence can act outside the forward light cone has recently been tightly linked to the corresponding question for a much simpler model theory that enjoys all of the pertinent properties of quantum theory but is much easier to fully comprehend. It is shown here that, contrary to recent claims, the model theory is incompatible with the locality idea mentioned above. The logical structure of the argument, which is similar to the one employed for quantum theory, is discussed.

48421 **Renormalized fermion propagator in hot gauge theories.** Pisarski, R.D. (Fermi National Accelerator Lab., Batavia, IL (USA)). *Nuclear Physics [Section] A (Netherlands),* 498: 498 (10 Jul 1989). (CONF-8809203–: Quark Matter '88: 7th international conference on ultrarelativistic nucleus-nucleus collisions, Lenox, MA (USA), 26-30 Sep 1988).

The high temperature limit of the renormalized fermion propagator is calculated perturbatively for both massless and light, massive fermions. Collective excitations appear, for which the usual relation between chirality and helicity is flipped. (orig.).

48422 **Divergences and involution-dependent constants.** Nagao, G. (Texas Univ., Austin, TX (USA). Center for Particle Theory). *Modern Physics Letters A (USA),* 4(5): 445-450 (1989).

The authors show the cancellation of the dilation divergence in the 1-loop open bosonic string vacuum and N-tachyon scattering amplitude depends upon a set of involution-dependent constants. Such a set of constants exists at each loop level and thus provides a means with which to study the connection between the cancellation of divergences and anomalies for the gauge group $SO(2^D2/)$.

48423 **Non-standard bosonization techniques in conformal field theory.** Kiritsis, E.B. (California Univ., Berkeley, CA (USA).

Dept. of Physics). *Modern Physics Letters A (USA),* 4(5): 437-443 (1989).

It is shown that G/H models can be constructed in terms of a number of free bosons with a stress energy tensor that contains vertex operators. Generalizations of this technique are also discussed.

48424 Absence of wavefunction renormalization in Polyakov amplitudes. Bern, Z. (Los Alamos National Lab., NM (USA)); Kosower, D.A. *Nuclear Physics [Section] B (Netherlands),* 321(3): 605-628 (31 Jul 1989).

The correct interpretation of recent coupling constant renormalization calculations shows that there is no one-loop contribution to wavefunction renormalization for closed Polyakov string amplitudes with massless vector external states. (orig.).

48425 The classical harmonic oscillator on Galois and P-adic fields. Meurice, Y. (Argonne National Lab., IL (USA). High Energy Physics Div.). *International Journal of Modern Physics A (USA),* 4(9): 2211-2234 (1989).

Starting from a difference equation corresponding to the harmonic oscillator, the authors discuss various properties of the classical motion (cycles, conserved quantity, boundedness, continuum limit) when the dynamical variables take their values on Galois or rho-adic fields. They show that these properties can be applied as a technical tool to calculate the motion on the real numbers. They also give an example where the motions over Galois and rho-adic fields have a direct physical interpretation. Some perspectives for quantum field theory and strings are briefly discussed.

65 PHYSICS II

Refer also to citation(s) 48172, 48173

6510 Nuclear Physics

Refer also to citation(s) 47796, 48245, 48319, 48464

48426 (ANL–89/11) **Physics Division annual review, April 1, 1988–March 31, 1989.** Thayer, K.J. (ed.). Argonne National Lab., IL (USA). Aug 1989. 321p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE90000003/JAW. Available from NTIS, PC A15/MF A01; OSTI; INIS; GPO Dep.

This document discusses the following main topics: Research at Atlas; Operation and Development of Atlas; Medium-Energy Nuclear Physics and Weak Interactions; Theoretical Nuclear Physics; Interactions of Fast Atomic and Molecular Ions with Solid and Gaseous Targets; Atomic Physics at Synchrotron Light Sources; Atomic Physics at Atlas and the ECR Source; Theoretical Atomic Physics; High-Resolution Laser-rf Spectroscopy of Atomic and Molecular Beams; and Fast Ion-Beam/Laser Studies of Atomic and Molecular Structure.

48427 (ANU-P–1016) **Reduced electric-octupole transition probabilities, B(E3;O_1^+ -> 3_1^-), for even-even nuclides throughout the periodic table.** Spear, R.H. Australian National Univ., Canberra (Australia). Dept. of Nuclear Physics. Nov 1988. 75p. Order Number DE90601106/JAW. Available from NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS.

To be published in At. Data Nucl. Data Tables.

Adopted values for the excitation energy, $E_x(3_{1(sup-)})$, of the first 3^- state of the even-even nuclei are tabulated. Values of the reduced electric-octupole transition probability, B(E3;$O_{1(sup+)}$ -> $3_{1(sup-)}$), from the ground state to this state, as determined from Coulomb excitation, lifetime measurements, inelastic electron scattering, deformation parameters β_3 obtained from angular distributions of inelastically scattered nucleons and light ions, and other miscellaneous procedures are listed in separate Tables. Adopted values for B(E3; $O_{1(sup+)}$ -> $3_{1(sup-)}$) are presented in Table VII, together with the E3 transition strengths, in Weisskopf units, and the product $E_x(3_{1(sup-)})$ x B(E3; $O_{1(sup+)}$ -> 3_1^-) expressed as a percentage of the energy-weighted E3 sum-rule strength. An evaluation is made of the reliability of B(E3; $O_{1(sup+)}$ -> $3_{1(sup-)}$) values deduced from deformation parameters β_3. The literature has been covered to March 1988.

48428 (ANU-P–1034) **Pre-scission particle and gamma-ray emission in heavy-ion induced fission.** Newton, J.O. Australian National Univ., Canberra (Australia). Dept. of Nuclear Physics. Feb 1989. 72p. Order Number DE90601107/JAW. Available from NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS.

To appear in a special edition of Pramana to commemorate fifty years of fission.

An introduction is given to the physics of the equilibrium transition model and of dissipative nuclear dynamics. Experimental data on pre-scission particle and gamma-ray emission and their interpretation are reviewed. They appear to indicate overdamped motion of the nuclear fluid. A time scale for compound-nucleus fission of about $30x10^{-21}$ sec or greater is indicated, whilst that for quasi- or fast-fission is somewhat shorter. 99 refs., 28 figs.

48429 (DOE/ER/40020–T4) **Assessment of the current status of basic nuclear data compilations.** National Research Council, Washington, DC (USA). Panel on Basic Nuclear Data Compilations. 1989. 32p. Sponsored by U.S. DOE Energy Research. DOE Contract FG01-81ER40020. Order Number DE89015517/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Panel on Basic Nuclear Data Compilations met at the National Nuclear Data Center at Brookhaven National Laboratory (BNL). All 7 panel members were present, together with 17 other individuals with various responsibilities and interests in the US Nuclear Data Network (USNDN). Status reports were presented to the panel by the five US evaluation centers, located at Brookhaven (BNL), Idaho Falls (INEL), Berkeley (LBL), Oak Ridge (ORNL), and the University of Pennsylvania. The reports from the centers outlined the status of their mass chain evaluations and of a number of other projects related to this work; these areas are discussed in more detail in this report.

48430 (DOE/ER/40048–226-L9) **Nuclear Physics Laboratory, University of Washington annual report, 1989.** Washington Univ., Seattle, WA (USA). Nuclear Physics Lab. Apr 1989. 81p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-81ER40048. Order Number DE89017274/JAW. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

This report discusses the following topics: astrophysics; giant resonances; heavy ion induced reactions; fundamental symmetries; nuclear reaction – polarization; medium energy reactions; accelerator mass spectroscopy; research by outside users; van de Graaff and ion sources; computer systems; instrumentation; and booster linac.

48431 (GSI–89-1) **GSI scientific report 1988.** Grundinger, U. (ed.). Gesellschaft fuer Schwerionenforschung m.b.H., Darmstadt (Germany, F.R.). Mar 1989. 484p. Order Number DE90702847/JAW. Available from NTIS (US Sales Only), PC A21/MF A01.

This annual report contains extended abstracts about the work performed at the named institute. It concerns nuclear structure studies, heavy ion reactions, nuclear theory, atomic collisions, radiation effects in biological systems and solids, nuclear chemistry, as well as developments in counting techniques and accelerators. (HSI).

48432 (HMI-B–466) **HMI Section of Nuclear and Radiation Physics - annual report 1988.** Hahn-Meitner-Institut Berlin G.m.b.H. (Germany, F.R.). Bereich Kern- und Strahlenphysik. 1988. 270p. (In German). Order Number DE90703167/JAW. Available from NTIS (US Sales Only), PC A12/MF A01.

This annual report contains extended abstracts about the work performed in the named institute together with a list of publications and talks. The work concerns nuclear and atomic theory, heavy ion reactions, hyperfine-structure studies, ion collisions with atoms and solids, and developments on the VICKSI accelerator. (HSI).

48433 (JAERI-M–89-083) **Measurement of activation cross sections.** Katoh, Toshio; Kawade, Kiyoshi; Yamamoto, Hiroshi. Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Physics Div. c 1989. 61p. (In Japanese). Sponsored by Japan Atomic Energy Research Institute. (NEANDC(J)–137/U;INDC(JPN)–124/L). Available from Japan Atomic Energy Research Institute, Tokai-mura, Naka-gun, Ibaraki-ken 319-11, Japan.

Fifteen neutron activation cross sections for (n,2n), (n,p), (n,n'p) and (n,α) reactions producing short-lived nuclei have been measured in the energy range of 13.4 to 14.9 MeV for N, P, V, Fe, Ni, Cu, Sr, Zr, Mo and In. Cross sections for ^{58}Ni(n,t), ^{92}Mo(n, n'α) and ^{141}Pr(n,t) reactions were also measured. Half-lives of ^{13}N, ^{18}F, ^{28}Al, ^{37}S, ^{38}K, ^{42}K, ^{52}V, ^{62}Cu, ^{94m}Nb and ^{116m}In were measured with relative uncertainties of 0.05 to 0.8 percent. These short-lived nuclei were produced by 14 MeV or thermal neutron irradiations.

48434 (ORNL/FTR–2893) **[A proposal for research to use the GANIL accelerator facility at Caen, France, May 30–31, 1988]: Foreign trip report.** Horen, D.J. Oak Ridge National Lab., TN (USA). 7 Jun 1988. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017487/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler attended the meeting of the Program Advisory Committee of the GANIL accelerator facility to present a proposal for research there. The experiment, which can only be carried out at GANIL, is part of the ORNL Physics Division research program, and ORNL staff members serve as spokesmen for the experiment. The traveler also engaged in discussions with some of our collaborators who are located at GANIL. The proposal was well received by the committee, which approved our full request for beam time.

48435 (ORNL/FTR–2894) **[Mass-chain nuclear structure and nuclear decay, Ghent, Belgium, May 16–20, 1988]: Foreign trip report.** Martin, M.J. Oak Ridge National Lab., TN (USA). 8 Jun 1988. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017276/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler participated in the meeting, the main purpose of which was to continue the coordination and development of the international network of centers for the compilation, evaluation, and exchange of mass-chain nuclear structure and decay data.

48436 (ORNL/FTR–3166) **[Work outline for the Japan/US actinides program]: Foreign trip report, January 17–26, 1989.** Raman, S. Oak Ridge National Lab., TN (USA). 9 Feb 1989. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017375/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler presented a progress report to personnel at the Japan Atomic Energy Research Institute (JAERI), Tokai Establishment, on work carried out at ORNL under the Japan/US Actinides Program. He also briefed personnel at Nagoya University and the Central Research Institute of Electric Power Industry (CRIEPI). He developed a draft of the work plan for Japanese approval and funding during the ensuing Japanese fiscal year. He spent one day at the Tokyo Institute of Technology to work on a joint research paper.

6511 Experimental Techniques

48437 (DOE/ER/40048–222-L9) **Eot-Wash constraints on multiple Yukawa interactions and on a coupling to "isospin".** Stubbs, C.W. Eot-Wash collaboration. Washington Univ., Seattle, WA (USA). Dept. of Physics. 1989. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-81ER40048. (CONF-890199–7: 24. Rencontre de Moriond on tests of fundamental laws in physics, Les Arcs (France), 21-28 Jan 1989). Order Number DE89017311/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The final results of our lead-source runs are presented. Our data rule out at 2σ the possibility of accounting for all the composition-dependent results in terms of a coupling to "isospin." By exploiting the fact that our hillside layout is fairly complex, we have also set limits on multiple-Yukawa scenarios. 15 refs., 3 figs.

6513 Nuclear Properties and Reactions, A=6-19, Experimental

48438 (ANU-P–1029) **Alpha-particle decay widths of levels in ^{19}F.** Pringle, D.M.; Vermeer, W.J. Australian National Univ., Canberra (Australia). Dept. of Nuclear Physics. Feb 1989. 24p. Order Number DE90601108/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Accepted for publication in Nucl. Phys., A.

Levels of ^{19}F in the excitation region $4<E_x<11$ MeV were studied with the ^{12}C(^{11}B, α) reaction, using a recoil-coincidence technique to measure values of Γ_γ/Γ. The information obtained has been combined with known values of $\omega\gamma$ to determine alpha-particle widths in the range $\sim$ 1-100 eV for various levels. The highest lying level observed to have a significant gamma-decay probability was a new level at E_x = 10.927 +- 0.008 MeV with Γ_γ/Γ = 0.051 +- 0.004. The $11/2_4^-$, 9.873 MeV level was observed to have a surprisingly large value for Γ_γ/Γ of 0.43 +- 0.04, which gives Γ_α = 1.4 +- 0.3 eV, Γ_{rho} = 0.10 +- 0.03 eV, and a total width Γ 2.6 +- 0.4 eV. The present measurements of Γ_α for the $11/2_1^-$ and $11/2_4^-$ levels, together with previous information for the $11/2_2^-$ and $11/2_3^-$ levels, provide for the first time a complete unambiguous picture of the distribution of alpha-strength among these $11/2^-$ levels and clarify a long outstanding problem concerning the $11/2^-$ member of the $K^\pi = 1/2^-$ alpha-cluster band. We conclude that the $11/2_2^-$, 8.953 MeV level is the best candidate for this alpha-cluster state, and there is very little configuration mixing among the $11/2^-$ levels. 2 figs., 6 tabs.

48439 (ANU-P–1035) **Value of B(E2;3/2$^-$ -> 1/2$^-$) for ^{7}Li.** Vermeer, W.J.; Spear, R.H.; Barker, F.C. Australian National Univ., Canberra (Australia). Dept. of Nuclear Physics. 1989. 16p. Order Number DE90601109/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Accepted for publication in Nucl. Phys., A.

Previous experimental information from the Coulomb excitation of the $1/2^-$ first excited state of ^{7}Li is discussed and reanalysed, giving B(E2;$3/2^-$ -> $1/2^-$) = 7.59 +- 0.10e^2fm^4. 28 refs., 3 tabs., 1 fig.

48440 **Nuclear-target effects in J/psi production in anti p and π^- interactions.** Wagner, R.L. (Fermi National Accelerator Lab., Batavia, IL (USA)). E537 Collaboration. *Nuclear Physics [Section] A (Netherlands),* 498: 498 (10 Jul 1989). (CONF-8809203–: Quark Matter '88: 7th international conference on ultrarelativistic nucleus-nucleus collisions, Lenox, MA (USA), 26-30 Sep 1988).

The cross sections of J/psi hadroproduction in Be, Cu, and W targets are presented as functions of Feynman-x (x_F) and transverse momentum (p_T). A suppression of the forward cross section per nucleon in heavy targets is observed; the suppression increases with increasing x_F and decreases with increasing p_T. The data are compared with other J/psi hadroproduction data and data from the Drell-Yan production of muon pairs, J/psi photoproduction and open charm hadroproduction. (orig.).

6514 Nuclear Properties and Reactions, A=20-38, Experimental

48441 (ANU-P–1011) **Observations of ^{20}N via the heavy-ion transfer reaction ^{48}Ca(^{18}O,^{20}N)^{46}Sc.** Orr, N.A.; Catford, W.N.; Fifield, L.K.; Hotchkis, M.A.C.; Ophel, T.R.; Weisser, D.C.; Woods, C.L. Australian National Univ., Canberra (Australia). Dept. of Nuclear Physics. Oct 1988. 27p. Order Number DE90601112/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Accepted for publication in Nucl. Phys., A.

The Q-values for groups observed in the multi-nucleon transfer reaction ^{48}Ca(^{18}O,^{20}N)^{46}Sc have been measured using a variety of heavy-ion spectrographic techniques. The group at lowest excitation energy has a Q-value of -25.87 +- 0.02 MeV, corresponding to a mass excess of 22.63 +- 0.06 MeV for ^{20}N. This is in significant disagreement with earlier determinations, being $\sim$ 1 MeV less bound. Possible explanations are discussed.

48442 (ANU-P–1012) **Reaction studies of the neutron-rich nuclei ^{22,23}F.** Orr, N.A.; Fifield, L.K.; Catford, W.N.; Woods, C.L. Australian National Univ., Canberra (Australia). Dept. of Nuclear Physics. Oct 1988. 21p. Order Number DE90601113/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Accepted for publication in Nucl. Phys., A.

The masses and excited states of the neutron-rich nuclei ^{22}F and ^{23}F have been measured using the heavy-ion transfer reactions ^{22}Ne(^{7}Li,^{7}Be)^{22}F and ^{22}Ne(^{18}O,^{17}F)^{23}F. Mass excesses of 2.80 +- 0.02 Mev and 3.32 +- 0.09 Mev respectively were deduced from the

reaction Q-values. The value for ^{22}F differs from that previously accepted due to the existence of a low-lying doublet. A number of excited states have been identified in both nuclei, and the results are compared with shell model calculations.

48443 (ANU-P–1026) **Yrast 8$^+$ and 9$^+$ states of ^{22}Na.** Vermeer, W.J.; Pringle, D.M.; Garman, E.F.; Wright, I.F. Australian National Univ., Canberra (Australia). Dept. of Nuclear Physics. 1988. 13p. Order Number DE90601114/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Gamma-decaying high-spin states of ^{22}Na populated in the ^{12}C(^{14}N,α) reaction were studied, using a recoil-coincidence technique to measure values of Γ_γ/Γ and an α-γ coincidence arrangement to measure lifetimes and γ-decay branches. Good candidates have been found for the yrast 8$^+$ and 9$^+$ levels at excitation energies of 8572 +- 3 and 9813 +- keV respectively. Their properties are compared with those predicted by the shell model and test these calculations in the region where band termination is expected.

48444 Results from WA80 on transverse energy production, fluctuations in multiparticle production, and γ/π^0 ratios. Young, G.R. (Oak Ridge National Lab., TN (USA)); Awes, T.C.; Baktash, C.; Ferguson, R.L.; Lee, I.Y.; Obenshain, F.E.; Plasil, F.; Saini, S.; Tincknell, M.L.; Albrecht, R. WA80 Collaboration. *Nuclear Physics [Section] A (Netherlands)*, 498: 498 (10 Jul 1989). (CONF-8809203–: Quark Matter '88: 7th international conference on ultrarelativistic nucleus-nucleus collisions, Lenox, MA (USA), 26-30 Sep 1988).

Results are presented concerning transverse energy production from the WA80 run of 1987 using beams of E/A=200 GeV ^{32}S produced by the CERN SPS. Comparisons are made to the earlier results obtained with E/A=60 and 200 GeV ^{16}O. The results of an analysis of fluctuations in the charged-particle pseudorapidity densities for the ^{16}O data are presented next. These analyses were carried out following a method suggested by Bialas and Peschanski. This reveals fluctuations down to pseudorapidity scales of δeta=0.1. Finally, a preliminary value is presented for the excess of observed photons over known sources in reactions of E/A=200 GeV ^{16}O+Au. These measurements span the pseudorapidity interval 1.5<eta<2.1 and transverse momentum range p_T=0.4-2.4 GeV/c. This excess is observed for central O+Au collisions but not peripheral O+Au collisions. (orig.).

6515 Nuclear Properties and Reactions, A=39-58, Experimental

48445 (AD-A–207446/6/XAB) **Demonstration of the feasibility of the tuning and stimulation of nuclear radiation. Final report, 1 July 1981-31 October 1988.** Collins, C.B. Texas Univ., Dallas, TX (USA). 31 Oct 1988. 252p. (N–00014-81-K-0653). Available from NTIS, PC A12/MF A01.

A major effect was found that had defied the construction of a completely satisfactory explanation in terms involving only conventional processes of incoherent excitation. It was the generation of radiofrequency sidebands on the hyperfine Moessbauer spectra of ^{57}Fe in ferromagnetic environments. Through the application to a ferromagnetic iron foil of a magnetic field oscillating at radiofrequencies, several new spectral lines were produced in addition to the usual six hyperfine components of the 14.4-keV transition in ^{57}Fe. A persistent complication arose from the geometry in which the radiofrequency H field was generally applied in the plane of the absorber foil, so that magnetostriction occurred in the direction perpendicular to the axis of propagation of the gamma radiation. Very significant was the result that unlike the paramagnetic case this new model predicted a dependence of sideband intensity upon power that was drastically different from the magnetostrictive theories. Even more significant was that the new multiphoton model of nuclear sidebands was comprehensive enough to suggest new extrapolations and effects not previously apparent. The most exciting was the extensive range over which sidebands might be tuned.

48446 (ANU-P–997) **Study of ^{51}Ca via three-neutron transfer.** Catford, W.N.; Fifield, L.K.; Ophel, T.R.; Orr, N.A.; Weisser, D.C.; Woods, C.L. Australian National Univ., Canberra (Australia). Dept. of Nuclear Physics. Sep 1988. 41p. Order Number DE90601115/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Accepted for publication in Nucl. Phys., A.

Low-lying levels in ^{51}Ca have been studied via the reaction ^{48}Ca(^{18}O,^{15}O)^{51}Ca at a beam energy of 108 MeV. Recoiling ^{51}Ca nuclei were detected in coincidence with ^{15}O ejectiles, largely removing the substantial background from target contaminants that was encountered in previous work. The lowest ^{51}Ca level identified is 1.01 +- 0.11 MeV less bound than the ground state, according to a recent measurement of the ground state mass using the ^{48}Ca(^{14}C,^{11}C)^{51}Ca reaction. Considerations of the difficulty in identifying the ground state peak suggest that published values of the mass excess should be viewed with caution, and that a definitive mass measurement is still required in order to resolve questions on the structure of the neutron rich calcium isotopes. A total of six energy levels in ^{51}Ca have been identified and their mass excesses measured. Only two of these levels have been observed previously, via the (^{14}C,^{11}C) reaction. Striking differences in selectivity between the (^{18}O,^{15}O) and (^{14}C,^{11}C) transfer reactions are discussed.

48447 (JAERI-M–89-089) **Measurements of gamma-ray production nuclear data of calcium and chromium.** Igashira, Masayuki; Kitazawa, Hideo. Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan). Tokai Research Establishment. c Jul 1989. 52p. (In Japanese). Sponsored by Japan Atomic Energy Research Institute. (NEANDC(J)–138/U;INDC(JPN)–125/L). Available from Japan Atomic Energy Research Institute, Tokai-mura, Naka-gun, Ibaraki-ken 319-11, Japan.

Neutron capture gamma-ray spectra of calcium and chromium have been measured, using the 3UH-HC Pelletron accelerator and an anti-Compton NaI(Tl) gamma-ray detector of the Research Laboratory for Nuclear Reactors in the Tokyo Institute of Technology. Incident neutron energy regions were 17 $\sim$ 26 keV, 31 $\sim$ 59 keV, 60 $\sim$ 132 keV, and 543 $\pm$ 33 keV for calcium, and 22 $\sim$ 20 keV, 41 $\sim$ 72 keV, 73 $\sim$ 144 keV, and 545 $\pm$ 32 keV for chromium. Measured capture gamma-ray pulse-height spectra were unfolded to obtain capture gamma-ray spectra, using a response matrix of the detector. Experimental results were compared with calculated ones based on a statistical model of the nuclei. The calculations reproduced well the observed spectra for both elements. 18 refs., 45 figs., 9 tabs.

6516 Nuclear Properties and Reactions, A=59-89, Experimental

Refer also to citation(s) 48440, 48444

48448 (INIS-BR–1586) **Measurements of fusion cross section for ^{12}C +^{63,65} Cu systems.** Rocha, C.A. da. Sao Paulo Univ., SP (Brazil). Inst. de Fisica. 1987. 150p. (In Portuguese). Order Number DE90601116/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Cross-section measurements for nuclear fusion in the ^{12}C+^{63,65}Cu system, at ^{12}C energy range from 0.9 to 1.8 times the Coulomb barrier are presented. In order to detect and to obtain the mass identification of the evaporation residues following the fusion process, the time of flight method was adopted in conjunction with an eletrostatic deflector capable of separating the evaporation residues from the beam particles. The limitation and advantadges of this method of measurement are discussed. The excitation functions were analysed using the unidimensional barrier penetration model with different nuclear potentials. Theoretical fusion cross-section values obtained from this analysis were systematically smaller than our measured values, in the energy region below the Coulomb barrier. In order to discover which channel enhances the fusion cross-section in this region, a coupled channel calculation was performed, with the CCFUS code. The experimental data for the above reactions were compared with the systems^{16,18}O+^{63,65}Cu, measured by our group. In this comparison, it was noted that the systems ^{12}C+^{63,65}Cu, have greater fusion cross section below the Coulomb barrier. The comparison of velocity spectra of the evaporated residues for the two systems shows that ^{12}C+^{63}Cu has a strong reaction channel that was not present in the ^{12}C+^{65} Cu system. (author).

6517 Nuclear Properties and Reactions, A=90-149, Experimental

Refer also to citation(s) 48444

48449 (ANU-P–1018) **Measurement of reduced electric octupole transition probabilities B(E3;0_1^+ -> 3_1^-), for ^{118,120,122}Sn.** Spear, R.H.; Baxter, A.M.; Burnett, S.M.; Miller, C.L. Australian National Univ., Canberra (Australia). Dept. of Nuclear Physics. Oct 1988. 13p. Order Number DE90601117/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Accepted for publication in Aust. J. Phys.

Values of reduced electric octupole transition probabilities B(E3;0_1^+ -> 3_1^-) for the nuclides ^{118,120,122}Sn have been determined using Coulomb excitation with ^{12}C projectiles. The results are in good agreement with shell-model calculations made without introducing effective charges but involving core excitations. Values for B(E2;0_1^+ -> 2_1^+) are also presented.

48450 (ANU-P–1020) **Mixed-symmetry in the vibrational nucleus ^{142}Ce.** Vermeer, W.J.; Lim, C.S.; Spear, R.H. Australian National Univ., Canberra (Australia). Dept. of Nuclear Physics. Nov 1988. 10p. Order Number DE90601118/JAW. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS.

Low-lying levels of the nucleus ^{142}Ce have been studied by Coulomb excitation with ^{4}He, ^{12}C, and ^{16}O projectiles to determine the various B(Eλ) values and the static quadrupole moment Q(2_1^+). Excellent agreement is found between the observed properties and predictions made using the U(5) limit of IBM-2. The results strongly support the contention that the 2_3^+, 2.004-MeV level has mixed proton-neutron symmetry. Combining the present measurement for B(E2;0_1^+ -> 2_3^+) of 0.070 +- 0.011 e^2b^2 with known branching and mixing ratios gives a substantial M1 strength of 0.26 +- 0.05 μ_N^2 for the 2_3^+ -> 2_1^+ transition.

48451 (ANU-P–1033) **Electric quadrupole moments of the first excited states of ^{130,134,138}Ba.** Burnett, S.M.; Baxter, A.M.; Gyapong, G.J.; Fewell, M.P.; Spear, R.H. Australian National Univ., Canberra (Australia). Dept. of Nuclear Physics. Jan 1989. 38p. Order Number DE90601119/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Accepted for publication in Nucl. Phys., A.

The static electric quadrupole moments Q(2^+_1) of the first excited states of ^{138,134,130}Ba and the reduced transition probabilities B(E2;0^+_1 -> 2^+_1) have been measured using the reorientation effect in Coulomb excitation. It is found for ^{138}Ba that Q(2^+_1) = - 0.14(7) [0.08(7)] e.b, where in this and the following cases the unbracketed value corresponds to constructive interference from the 2^+_2 state and the bracketed value corresponds to destructive interference; for ^{134}Ba Q(2^+_1) - 0.32(6) [0.09(6)]e.b for $P_3(4^+_1)<0$ or Q(2^+_1) = - 0.20(6) [0.21(6)]e.b for $P_3(4^+_1)>0$; for ^{130}Ba if it is assumed that the mixing ratio δ (E2/M1; 2^+_2 -> 2^+_1) >> 1 then Q(2^+_1) - 1.02(15) [- 0.09(15)]e.b. Results obtained for B(E2; 0^+_1 -> 2^+_1) are 0.241(6)$e^2.b^2$, 0.655(6)$e^2.b^2$ and 1.167(11) [1.158(12)]$e^2.b^2$ for ^{138,134,130}Ba respectively. The results are compared with previous measurements and with the predictions of various nuclear models.

48452 (ORNL/FTR–3142) **[Isoscalar quadrupole resonances in ^{90,96}Zr and ^{112,118,124}Sn by inelastic scattering of ^{17}O ions]: Foreign trip report, November 5–December 13, 1988.** Horen, D.J. Oak Ridge National Lab., TN (USA). 14 Dec 1988. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017373/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler participated in an ORNL Physics Division experiment at GANIL, Caen, France, to measure the isoscalar quadrupole resonances in ^{90,96}Zr and ^{112,118,124}Sn by inelastic scattering of ^{17}O ions. The traveler coordinated setup of the experimental conditions for data accumulation and supervised and participated in data analysis. This experiment was feasible because the use of 84-MeV/nucleon heavy-ion beams, available only at GANIL, yielded large cross sections for which interference between Coulomb and nuclear excitation provided a signature for deducing the isospin character of the resonance. This experiment was a collaboration with researchers from ORNL, GANIL, and Saclay. The traveler also presented invited seminars entitled "The Time for the Study of Giant Resonances with Heavy Ions Has Arrived" at GANIL and at the INFN, Naples. At the INFN, the traveler discussed results of data obtained in an experiment at ORNL pertaining to the two-octupole-phonon excitation in ^{208}Pb.

6518 Nuclear Properties and Reactions, A=150-189, Experimental

Refer also to citation(s) 48440

48453 (ANU-P–1001) **Band crossing in ^{170}Os.** Dracoulis, G.D.; Bark, R.A.; Stuchbery, A.E.; Byrne, A.P.; Baxter, A.M.; Riess, F. Australian National Univ., Canberra (Australia). Dept. of Nuclear Physics. May 1988. 25p. Order Number DE90601121/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Accepted for publication in Nucl. Phys., A.

Excited states in the neutron-deficient nucleus ^{170}Os were identified up to spin (24^+) in the yrast band and to spin (23^-) in the lowest negative-parity band. Deformation systematics implied by the 2^+ state energies for the very light osmium isotopes are compared with theory. Band-crossing frequencies, alignments and alignment gains are compared with cranked shell model calculations. Deformation changes are required to obtain detailed agreement. A three-band mixing approach is invoked to explain the low spin yrast anomaly in ^{172}Os and to reproduce the yrast band in ^{170}Os. The excitation energy of the postulated intruder band in ^{170}0s and ^{172}Os is deduced.

6519 Nuclear Properties and Reactions, A=190-219, Experimental

Refer also to citation(s) 47839, 48293, 48444

48454 (ANU-P–1005) **Spectroscopy of ^{212}Rn.** Stuchbery, A.E.; Dracoulis, G.D.; Byrne, A.P.; Poletti, A.R. Australian National Univ., Canberra (Australia). Dept. of Nuclear Physics. Jun 1988. 30p. Order Number DE90601122/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Accepted for publication in Nucl. Phys., A.

Excited states of ^{212}Rn have been studied using γ-ray and electron spectroscopy following the reactions ^{208}Pb (^{9}Be,5n) and ^{204}Hg(^{13}C,5n). With the exception of the energy of the yrast 8^+ -> 6^+ transition, the previously proposed level scheme has been verified. New transitions have been placed in the level scheme and new lifetime and g-factor results obtained. The level scheme and electromagnetic properties of selected isomeric states are compared with the results of shell model and semi-empirical shell-model calculations, including coupling to octupole vibrations.

48455 (ANU-P–1025) **Possible discontinuity in octupole behaviour in the Pt-Hg region.** Lim, C.S.; Spear, R.H.; Vermeer, W.J.; Fewell, M.P. Australian National Univ., Canberra (Australia). Dept. of Nuclear Physics. Jan 1989. 10p. Order Number DE90601123/JAW. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS.

Accepted for publication in Phys. Rev., C.

Values of B(E3;0_1^+ -> 3_1^-) have been determined for the nuclei ^{194,196,198}Pt by Coulomb excitation, giving 0.125(8), 0.102(4), and 0.084(18) e^2b^3, respectively. The results are discussed within the context of a previously suggested discontinuity in octupole behaviour in the Pt-Hg region.

48456 (ANU-P–1031) **Properties of $15/2^-$ states in ^{215}Ra and ^{217}Th; evaluation of the $15/2^-$ to $9/2^+$ E3 strength in N=127 isotones.** Dracoulis, G.D.; Riess, R.; Stuchbery, A.E.; Bark, R.A.; Gupta, S.L.; Baxter, A.M.; Kruse, M. Australian National Univ., Canberra (Australia). Dept. of Nuclear Physics. 1988. 22p. Order Number DE90601124/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Accepted for publication in Nucl. Phys.

The lifetime of the yrast $15/2^-$ state in ^{215}Ra was measured using pulsed beams and γ-ray and electron techniques. Transition multipolarities were established from measured conversion coefficients. The B(E3) of the $15/2^-$ -> $9/2^+$ transition is found to be considerably larger than previously reported. A candidate for the

corresponding transition in ^{217}Th was also observed. The E3 strength of the $15/2^- \rightarrow 9/2^+$ transition in the N=127 isotones is evaluated in the light of these and other recent results. Interpretation in the framework of particle-octupole vibration coupling requires a systematic lowering of the core 3^- vibration as proton pairs are added to ^{208}Pb.

48457 (CONF-890686–1) **Excitation and decay of giant multipole resonances in intermediate energy heavy ion reactions.** Beene, J.R.; Bertrand, F.E. Oak Ridge National Lab., TN (USA). 1989. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From International conference on new aspects of nuclear spectroscopy; Crete (Greece); 26-30 Jun 1989. Order Number DE89017770/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The role of intermediate energy heavy ions in the study of giant multipole resonances is explored, with emphasis on gamma decay coincidence experiments. Experiments on ^{208}Pb bombarded by 84 MeV/nucleon ^{17}O are discussed and compared with earlier work at 22 MeV/nucleon. The role of Coulomb excitation in the 84 MeV/nucleon data is emphasized and some consequences for study of isovector resonance strength are explored. A comparison of the excitation and decay of the isovector giant dipole resonance in ^{208}Pb and ^{209}Bi excited with 84 MeV/nucleon ^{17}O scattering is presented. 35 refs., 16 figs., 1 tab.

48458 (CONF-890826–3) **Fluctuations in transverse energy and multiplicity, energy densities, and neutral pion spectra in nucleus-nucleus collissions at 200 GeV/nucleon.** Plasil, F.; Albrecht, R.; Awes, T.C.; Baktash, C.; Beckmann, P.; Berger, F.; Bock, R.; Claesson, G.; Clewing, G.; Dragon, L. WA80 Collaboration. Oak Ridge National Lab., TN (USA). 1989. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From International nuclear physics conference; Sao Paulo (Brazil); 20-26 Aug 1989. Order Number DE89017583/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The main goal of the CERN heavy-ion experiments is the search for an indication that the predicted state of deconfined quarks and gluons, the quark-gluon plasma (QGP), has been produced. The quantity most crucial to the probability of QGP formation is the thermalized energy density attained during the heavy-ion reaction. The amount of energy radiated transverse to the beam direction is the experimental quantity which is believed to be a measure of the amount of energy deposition in the reaction, and hence to reflect the energy density attained. In this presentation we consider the systematics of transverse energy production at CERN SPS energies, and we use the results to make estimates, under various assumptions, of attained energy densities. Measurements of direct photons and lepton pairs are considered to be among the most promising methods for studies of the QGP. In contrast to hadrons, direct photons are not expected to undergo any interactions after their creation. The WA80 collaboration has undertaken the measurement of direct photons, which is a difficult task due to the presence of a high background of photons from the decay of neutral pions. The π^0 spectra themselves, however, provide us with the opportunity to study the excited reaction zone during the hadronization phase. We present here measurements of neutral pions produced in ^{16}O + Au collisions at 200 GeV/nucleon. 22 refs., 11 figs.

48459 (ORNL/FTR–3222) **[Coulomb excitation with fast high Z ions: Gamma-gamma coincidence study of the IVGQR and the two-phonon giant resonance states in ^{208}Pb]: Foreign trip report, April 14–19, 1989.** Bertrand, F.E. Oak Ridge National Lab., TN (USA). 21 Apr 1989. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017351/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler presented a research proposal before the Program Advisory Committee at GANIL. The proposed experiment, entitled "Coulomb Excitation with Fast High Z Ions: Gamma-Gamma Coincidence Study of the IVGQR and the Two-Phonon Giant Resonance States in ^{208}Pb," utilizes 60 MeV/nucleon ^{86}Kr and 95 MeV/nucleon ^{36}Ar beams. The GANIL facility is the only facility in the world that has the beam energy, intensity, and quality that is required to carry out the measurements.

48460 (UCRL–101297) **Multifragmentation and fission in the reactions Nb + Au and Fe + Au at 50 to 100 MeV/A.** Namboodiri, M.N.; Britt, H.C.; Fields, D.J.; Hansen, L.F.; Lanier, R.G.; Massoletti, D.; Remington, B.A.; Sangster, T.C.; Struble, G.L.; Webb, M.L.; Begemann-Blaich, M.L.; Blaich, T.; Fowler, M.M.; Wilhelmy, J.; Chan, Y.D.; Dacal, A.; Harmon, A.; Pouliot, Lawrence Livermore National Lab., CA (USA). 1989. 15p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8904153–5: Symposium on nuclear dynamics and nuclear disassembly, Dallas, TX (USA), 9-14 Apr 1989). Order Number DE89017530/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We report preliminary results from exclusive measurements on the reactions Nb + Au and Fe + Au at 50 to 100 MeV/A. Correlations among target fragments, energetic light charged particles and projectile fragments have been measured. These correlations indicate that fission is the result of peripheral collisions in these systems. Collisions at intermediate impact parameters result in heavy residues which do not undergo fission. More central collisions result in intermediate mass fragments and high multiplicity of light particles. An important result of this study is that the cross sections for the major classes of products change very little over the energy range 50-100 MeV/A in the systems Nb + Au and Fe + Au. 9 refs., 12 figs.

6530 Nuclear Theory

Refer also to citation(s) 48178, 48245, 48259, 48426, 48428, 48430, 48432, 48667

48461 (AD-A–204555/7/XAB) **Fission-fusion adaptivity in finite elements for nonlinear dynamics of shells. Annual technical report, 1 October 1987-30 September 1988.** Belytschko, T. Northwestern Univ., Evanston, IL (USA). Dept. of Civil Engineering. 30 Nov 1988. 66p. Available from NTIS, PC A04/MF A01.

An adaptive finite-element procedure is developed for the transient analysis of nonlinear shells. The scheme is an h-method that employs fission and fusion of elements to adaptively refine and coarsen the mesh. Incremental work and deviation of the bilinear finite-element approximation to the shell from a Kirchhoff-Love surface are used as error criteria for adaptivity. The example problems show that the adaptive schemes are capable of achieving substantial improvements in accuracy for a given computational effort. They include both material and geometric nonlinearities and local and global buckling.

48462 (AD-A–205371/8/XAB) **Proof of the feasibility of coherent and incoherent schemes for pumping a gamma-ray laser. Quarterly technical progress report, 1 October-31 December 1988.** Collins, C.B. Texas Univ., Richardson, TX (USA). Center for Quantum Electronics. Jan 1989. 78p. (GRL–8803). Available from NTIS, PC A05/MF A01.

Recent approaches to the problem of the gamma-ray laser have focused upon upconversion techniques in which metastable nuclei are pumped with long-wavelength radiation. At the nuclear level the storage of energy can approach tera-Joules (1012J) per liter for thousands of years. However, any plan to use such a resource for a gamm-ray laser poses problems of a broad interdisciplinary nature requiring the fusion of concepts taken from relatively unrelated fields of physics. Since 1978 the author has pursued an approach for the upconversion of longer-wavelength radiation incident upon isomeric nuclear populations that can avoid many of the difficulties encountered with traditional concepts of single-photon pumping. Recent experiments have confirmed the general feasibility and have indicated that a gamma-ray laser is feasible and have indicated that a levels and branching ratios exist in some real material. A laser-grade data base of nuclear properties does not yet exist, but the techniques for constructing one have been developed under this contract and are now being utilized.

48463 (AD-A–207420/1/XAB) **Fission-product-decay characteristics. Master's thesis.** Millage, K.K. Air Force Inst. of Tech., Wright-Patterson AFB, OH (USA). School of Engineering. Mar 1989. 132p. (AFIT/GNE/ENP–89M-5). Available from NTIS, PC A07/MF A01.

This theses determined fission-product decay characteristics , including the total activity, the gamma-ray emission rate (GER) and gamma-ray energy spectra. The activity and GER decay were compared to Way and Wigner's t(exp(-1.2)) approximation, and the effects the spectra, activity, and GER have on the Source Normalization Constant (K) were examined. Most of the fission-product data were obtained from DKPOWR, and were compared with data obtained from ORIGIN2. Since the gamma rays are of primary concern in fallout studies, the GER is used instead of activity. The ratio of GER to activity changes significantly with time. Results of this study calculate a GER of 590 x 10^{16} gamma rays/second per kT of fission yield from U-235 fuel and a K of 7059 R/Hr/(kT/sq.km.). The calculation of K includes the contribution from scattered photons. The GER result is 11% higher than reference values, while the K is within 2% of the current value in Glasstone and Dolan's The Effects of Nuclear Weapons. The Ks for Pu-239 and U-238 were within 5% of the U-235 results. The wax-wigners t(exp(-1.2)) approximation differs from time dependent GER and K up to 85% for times less than 6 months. The approximation is not valid for the GER or K at times greater than 6 months. The approximation is within about 45%, for the activity from fission-product decay to at least 5 years. A more accurate measure of exposure requires a numerical integration of the time dependent GER and Source Normalization Constant.

48464 (ANU-P–1024) **Nuclear fission induced by heavy ions.** Newton, J.O. Australian National Univ., Canberra (Australia). Dept. of Nuclear Physics. Sep 1988. 145p. Order Number DE90601105/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Submitted to Sov. J. Part. Nucl.

Because the accelerators of the 50's and 60's mostly provided beams of light ions, well suited for studying individual quantum states of low angular momentum or reactions involving the transfer of one or two nucleons, the study of fission, being an example of large-scale collective motion, has until recently been outside of the mainstream of nuclear research. This situation has changed in recent years, due to the new generation of accelerators capable of producing beams of heavy ions with energies high enough to overcome the Coulomb barriers of all stable nuclei. These have made possible the study of new examples of large-scale collective motions, involving major rearrangements of nuclear matter, such as deep-inelastic collisions and heavy-ion fusion. Perhaps the most exciting development in the past few years is the discovery that dissipative effects (nuclear viscosity) play an important role in fission induced by heavy ions, contrary to earlier assumptions that the viscosity involved in fission was very weak and played only a minor role. This review will be mainly concerned with developments in heavy-ion induced fission during the last few years and have an emphasis on the very recent results on dissipative effects. Since heavy-ion bombardment usually results in compound systems with high excitation energies and angular momenta, shell effects might be expected to be small, and the subject of low energy fission, where they are important, will not be addressed. 285 refs., 58 figs.

48465 (DOE/ER/40048–224-L9) **Giant nuclear resonances.** Snover, K.A. Washington Univ., Seattle, WA (USA). 1989. 16p. Sponsored by U.S. DOE Energy Research. DOE Contract AC06-81ER40048. Order Number DE89017319/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Giant nuclear resonances are elementary mods of oscillation of the whole nucleus, closely related to the normal modes of oscillation of coupled mechanical systems. They occur systematically in most if not all nuclei, with oscillation energies typically in the range 10-30 MeV. One of the best - known examples is the giant electric dipole (El) resonance, in which all the protons and all the neutrons oscillate with opposite phase, producing a large time - varying electric dipole moment which acts as an effective antenna for radiating gamma ray. This paper discusses this mode as well as quadrupole and monopole modes.

48466 (DOE/ER/40322–075) **Theoretical studies in nuclear reactions and nuclear structure: Progress report.** Maryland Univ., College Park, MD (USA). Dept. of Physics and Astronomy. Aug 1989. 85p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-87ER40322. Order Number DE89017806/JAW. Available from NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.

During the past year, research in theoretical nuclear physics at the University of Maryland attained a number of exciting and important results. These are described in some detail throughout the report, but some of the highlights are as follows: large N_c QCD has been shown to place strong constraints on vacuum effects of hadronic field theories; color dielectric models of hadrons have been understood in terms of lattice QCD; we have completed a relativistic analysis of proton scattering to test virtual pair contributions; we have also re-derived the Mandelzweig-Wallace two-body Dirac equation in covariant form, and applied it to the atomic two-body bound states: hydrogen, muonium and positronium; we have carried out the first calculation of the triton binding energy with a realistic quark-based nucleon-nucleon interaction and have learned that new kinds of nonlocalities in the tensor force may produce unexpected results; and we have shown that the Quadronium Conjecture can lead to spontaneous creation of the atom with low momentum as required by the observations, and are constructing a model to quantify the Quadronium phenomenology of the e^+e^- Puzzle.

48467 (IC–89/92) **Study of the optical potential for hadron-nucleus scattering using Glauber's theory.** Tag Eldin, I.M.A.; Esmael, E.H.; Hassan, M.Y.M.; Comsan, M.N.H. International Centre for Theoretical Physics, Trieste (Italy). May 1989. 28p. Order Number DE90601099/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Intermediate energy optical potential has been calculated using Glauber's theory. Two- and three-body correlations to the density are included. The dependence of the volume integrals per nucleon and rms radii on energy of the incident hadron and mass number of the target nucleus are studied. The effect of choosing different forms of the density on the depth of the optical potential and rms radii is studied. It is found that they are sensitive to the choice of the density, however the volume integrals per nucleon of the optical potential are found to be not so sensitive to the density, but they are more dependent on the parameters of the NN scattering amplitude. The effect of higher order correlations is more important in the case of p-bar and pions scattering than in the case of proton scattering. (author). 25 refs, 4 figs, 12 tabs.

48468 (IC–89/123) **Theoretical study of cold nuclear fusion using barrier penetration approach.** Gupta, S.K.; Gupta, R.K. International Centre for Theoretical Physics, Trieste (Italy). Jun 1989. 8p. Order Number DE90601096/JAW. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS.

The cold nuclear fusion process is investigated in terms of barrier penetration calculations by considering both the deuteron-molecule and colliding deuteron-deuteron atoms. Atomic collisions with strongly screened interatomic potential and the resonant state formation can bring agreement with present experimental results. Analysis of the data in terms of the reaction rates is also discussed. (author). 13 refs, 1 tab.

48469 (IC–89/124) **Half-shell scattering on Coulomb-distorted Graz potentials.** Talukdar, B.; Yunus, A. International Centre for Theoretical Physics, Trieste (Italy). Jun 1989. 8p. Order Number DE90601097/JAW. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS.

A closed form expression is constructed for the off-shell Jost function for scattering by the Coulomb-distorted Graz separable potential. The result is presented in 'maximal reduced form' to make it particularly suitable for calculating half-shell T matrices. A case study is presented in support of this. The role of Coulomb interaction in p-p half-shell scattering in the $^1S_0$ channel is examined. (author). 14 refs, 1 tab.

48470 (IC–89/136) **Some theoretical aspects of cold fusion. A report.** Khadkikar, S.B. International Centre for Theoretical Physics, Trieste (Italy). Jun 1989. 3p. Order Number DE90601098/JAW. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS.

Some theoretical aspects of "cold fusion" as they have been discussed at the Erice meeting, namely the theories based on an effective mass of the electron larger than its physical mass are presented.

48471 (INIS-mf–11514, pp. 187-194) **Factors in EMC effect.** Chao Wei-Qin (Academia Sinica, Beijing, BJ (China). Inst. of High Energy Physics). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

EMC discovered that the momentum distribution of quarks in bounded nucleons in a nucleus is comparing with the one in a free nucleon. Why the momentum distribution of quark is moving to the lower region in nuclei? A common explanation is that the quarks in nuclei move in a larger confinement size than those in a free nucleon. What is the physical picture for this enlargement of the confinement size? If a certain picture is introduced, are there other physical factors accompanying with the change of the confinement size which should also influence the EMC effect, or show other physical results. An Analysis for two main pictures is presented. 8 refs., 2 figs., 1 tab. (M.F.W.).

48472 (INIS-mf–11514, pp. 347-352) **Size of the particle emission region in relativistic nuclear collisions from two-particle interferometry.** Bartke, J. (Institute of Nuclear Physics, Cracow (Poland)). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

Studying correlations between identical secondary particles with small relative momenta produced in high-energy nuclear collisions can give information on the dimensions of the emission region. The interactions to which this method ussually refered as two-particle interferometry, are reviewed. The mean radii of the particle emission region are estimated. 32 refs., 1 fig., 2 tabs. (M.F.W.).

48473 (LA-UR–89-2744) **An overview of relativistic hydrodynamics as applied to heavy ion reactions.** Strottman, D.D. Los Alamos National Lab., NM (USA). 1989. 20p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-8905143–14: NATO advanced study institute international advanced course on the nuclear equation of state, Peniscola (Spain), 12 May - 3 jun 1989). Order Number DE89016598/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The application of relativistic hydrodynamics as applied to heavy ions is reviewed. Constraints on the nuclear equation of state, as well as the form of the hydrodynamic equations imposed by causality are discussed. Successes (flow, side-splash, scaling) and shortcomings of one-fluid hydrodynamics are reviewed. Models for pion production within hydrodynamics and reasons for disagreement with experiment are assessed. Finally, the motivations for and the implementations of multi-fluid models are presented. 74 refs., 11 figs.

48474 (LA-UR–89-2788) **Calculated proton-induced thick-target neutron and radionuclide yields for $E_p \leq 100$ MeV.** Wilson, W.B.; Arthur, E.D.; Bozoian, M.; Perry, R.T.; Young, P.G. Los Alamos National Lab., NM (USA). 1989. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-8906186–5: Materials Research Society materials analysis workshop, Albuquerque, NM (USA), 14-17 Jun 1989). Order Number DE89016978/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Earlier proton-induced thick-target yield calculations have been extended in proton energy range and to additional target elements, using the proton stopping cross section data of Anderson and Ziegler and cross sections modeled with the GNASH code. The targets now described include Be, C, O, Ne, Al, Si, Fe, Co, Ni, Cu, W, Pb and Bi. Thick-target yields are presented for these thirteen targets, with most extending to 100 MeV. 13 refs., 3 figs., 13 tabs.

48475 (LA-UR–89-2981) **Low-energy pion double charge exchange and nucleon-nucleon correlations in nuclei.** Leitch, M.J. Los Alamos National Lab., NM (USA). [1989]. 23p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-8908131–1: 2. LAMPF workshop on pion-nucleus double charge exchange, Los Alamos, NM (USA), 9-11 Aug 1989). Order Number DE89016971/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Recent measurements of pion double-charge exchange (DCX) at energies 20 to 70 MeV are providing a new means for studying nucleon-nucleon correlations in nuclei. At these energies the nucleus is relatively transparent, allowing simpler theoretical models to be used in interpreting the data and leading to a clearer picture. Also the contribution to DCX of sequential charge-exchange scattering through the intermediate analog state is suppressed near 50 MeV and transitions through non-analog intermediate states become very important. Recent theoretical studies by several groups have shown that while transitions through the analog route involve relatively long nucleon-nucleon distances, those through non-analog intermediate states obtain nearly half their strength from nucleon pairs with less than 1 fermi separation. Thus DCX near 50 MeV is an excellent way to study short-range nucleon-nucleon correlations. 31 refs., 29 figs., 4 tabs.

48476 (ORNL/FTR–2932) **[Nucleus-nucleus collisions]: Foreign trip report, June 5–11, 1988.** Plasil, F. Oak Ridge National Lab., TN (USA). 30 Jun 1988. 3p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017436/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler attended the Third International Conference on Nucleus- Nucleus Collisions in St. Malo, France. The conference was attended by 450 physicists and provided a good review of the status of heavy-ion research from low to ultrarelativistic energies. The traveler was the convenor of the "Round Table Discussion" held during the closing session of the conference. The traveler proposed that the Fourth International Conference on Nucleus-Nucleus Collisions be held in Gatlinburg, Tennessee, in 1991. The present and voting members of the International Advisory Committee and of the National Organizing Committee deadlocked 10-10 between the traveler's proposal and a Japanese proposal.

48477 (ORNL/FTR–2936) **[Nucleus-Nucleus Collisions]: Foreign trip report, June 6, 1988–June 21, 1988.** Obenshain, F.E. WA80 Collaboration. Oak Ridge National Lab., TN (USA). 13 Jul 1988. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017438/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The purpose of this travel was to attend the Third International Conference on Nucleus-Nucleus Collisions at St. Malo, France; the XIXth International Symposium on Multiparticle Dynamics, "New Data and Theoretical Trends," Arles, France; and the WA80 collaboration meeting at Geneva, Switzerland. Merger discussions with the CERN experimental group NA35 were scheduled to follow the collaboration meeting; however, these discussions were cancelled until further notice.

48478 (ORNL/FTR–2940) **[Nuclear structure physics]: Foreign trip report, May 9–June 14, 1988.** Baktash, C. Oak Ridge National Lab., TN (USA). 29 Jun 1988. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017397/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler visited the Niels Bohr Institute in Copenhagen, Denmark, to analyze data from a joint ORNL-NBI experiment that was performed last summer at ORNL. He also participated in the Nuclear Structure Workshop held at NBI, May 16-20, 1988. On June 9-14 he attended the "International Conference on Contemporary Topics in Nuclear Structure Physics" held in Cocoyoc, Mexico.

48479 (ORNL/FTR–2980) **[Cluster structure in nuclear and subnuclear matter, Kyoto, Japan, July 25–29, 1988]: Foreign trip report.** Shapira, D. Oak Ridge National Lab., TN (USA). 19 Aug 1988. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017280/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The conference attended by the traveler is the fifth of a series dedicated to aspects of cluster structure in nuclear and subnuclear matter. Most of the talks dealt with experimental signatures and observation of cluster structure, and with the theoretical description of reactions between nuclei composed of clusters. This is a major international conference series and is always well attended by many physicists who specialize in the field.

48480 (ORNL/FTR–2988) **[Collective properties of light tungsten and osmium nuclei]: Foreign trip report, July 24, 1988–July 29, 1988.** Johnson, N.R. Oak Ridge National Lab., TN (USA). 10 Aug 1988. 13p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017489/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler presented an invited talk on "The Collective Properties of Light Tungsten and Osmium Nuclei" at the "A = 180 Workshop" held at the Lund Institute of Technology, Lund, Sweden. This was a specialized workshop attended by about 40 people, both experimentalists and theoreticians who are actively involved with studies of tungsten, osmium, platinum, and iridium nuclei in the mass region of about 170 to 190. This was a very profitable meeting for those of us who are intimately involved in determining the high-angular momentum properties of these nuclei, which have only begun to receive concentrated attention in the past 2-3 years. The workshop revealed that we are making considerable progress in understanding this region. It also revealed the numerous conflicts between experiment and theory and pointed out the directions both groups need to explore in order to achieve a cohesive understanding of this area of research. The visit to the Niels Bohr Institute, following the workshop, concentrated on discussions of collaborative research between that group and the ORNL group and of various technical aspects of their newly constructed Compton-suppression system.

48481 (ORNL/FTR–2992) **[Heavy ion physics]: Foreign trip report, July 17, 1988–August 4, 1988.** Halbert, M.L. Oak Ridge National Lab., TN (USA). 9 Aug 1988. 17p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017495/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler presented two invited papers, one entitled "Gamma Decay of Giant Resonances Excited by Heavy Ions" at the International Symposium on "Heavy-Ion Reactions and Nuclear Astrophysical Problems, " Tokyo, Japan, July 21-23, 1988, and the other entitled "Angular Momentum Effects in Subbarrier Fusion" at the Symposium on "Heavy-Ion Reaction Dynamics in Tandem Energy Region," Hitachi, Japan, August 1-3, 1988. He also attended "Cluster '88," the Fifth International Conference on Clustering Aspects in Nuclear and Subnuclear Systems, Kyoto, Japan, July 25-29, 1988. He visited three accelerator laboratories in Japan, two for nuclear research and one for commercial production of accelerators and related components. This report describes the highlights of this trip in chronological order and ends with a summary of the traveler's impressions.

48482 (ORNL/FTR–3025) **[International conference on nuclear physics]: Foreign trip report, May 20, 1988–August 31, 1988.** Wong, Cheuk-Yin. Oak Ridge National Lab., TN (USA). 12 Sep 1988. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017491/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler was assigned to the Institute for Nuclear Studies of the University of Tokyo for three months, and collaborated with Japanese theorists on various problems of common interest. Before and during this foreign assignment period, the traveler also attended three international conferences in Taiwan and Japan. The International Conference on Medium- and High-Energy Nuclear Physics at Taipei, Taiwan, was the first international conference in physics held in Taiwan. Among other topics, the subjects of discussion included heavy-ion collisions at high energies and the physics associated with the anomalous positron peaks observed in heavy-ion collisions. The International Conference on Clustering Aspects in Nuclear and Subnuclear Systems at Kyoto was the fifth in a series of cluster conferences. It reviewed recent advances in the physics of clusters. This year, there was also a special session on clustering phenomena revealed in electromagnetic interactions such as those which might be associated with the anomalous e^+ peaks in heavy-ion reactions. The International Symposium on Developments of Nuclear Clustering Dynamics was organized as a "post-conference" of the Cluster Conference in Kyoto. In addition to topics in cluster physics, heavy-ion reactions and fusion were also discussed.

48483 (ORNL/FTR–3167) **[Workshop on gross properties of nuclei and nuclear excitations]: Foreign trip report, January 12–February 4, 1989.** Plasil, F. Oak Ridge National Lab., TN (USA). 9 Feb 1989. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017427/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The traveler chaired a session at the Hirschegg meeting and presented an invited talk on WA80 results at the Bormio meeting. Both meetings included numerous presentations of interest. The discussion following the formal talks was particularly lively and interesting at the Bormio meeting. The WA80 collaboration meeting was very intense, and may have resulted in a new direction in the sense that the collaboration's major emphasis will probably shift from lead-fiber electromagnetic sampling calorimeters to BGO detectors.

48484 (UCRL–100547) **Detailed photonuclear cross-section calculations and astrophysical applications.** Gardner, D.G.; Gardner, M.A.; Hoff, R.W. Lawrence Livermore National Lab., CA (USA). 15 Jun 1989. 27p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-8905187–3: WEIN '89: international symposium on weak and electromagnetic interactions in nuclei, Montreal (Canada), 15-19 May 1989). Order Number DE89017531/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

We have investigated the role of an isomeric state and its coupling to the ground state (g.s.) via photons and neutron inelastic scattering in a stellar environment by making detailed photonuclear and neutron cross-section calculations for ^{176}Lu and ^{210}Bi. In the case of ^{176}Lu, the g.s. would function as an excellent galactic slow- (s-) process chronometer were it not for the 3.7-h isomer at 123 keV. Our calculations predicted much larger photon cross sections for production of the isomer, as well as a lower threshold, than had been assumed based on earlier measurements. These two factors combine to indicate that an enormous correction, a factor of 10^7, must be applied to shorten the current estimate of the half-life against photoexcitation of ^{176}Lu as a function of temperature. This severely limits the use of ^{176}Lu as a stellar chronometer and indicates a significantly lower temperature at which the two states reach thermal equilibrium. For ^{210}Bi, our preliminary calculations of the production and destruction of the 3×10^6 y isomeric state by neutrons and photons suggest that the ^{210}Bi isomer may not be destroyed by photons as rapidly as assumed in certain stellar environments. This leads to an alternate production path of ^{207}Pb and significantly affects presently interpreted lead isotopic abundances. We have been able to make such detailed nuclear cross-section calculations using: modern statistical-model codes of the Hauser-Feshbach type, with complete conservation of angular momentum and parity; reliable systematics of the input parameters required by these codes, including knowledge of the absolute gamma-ray strength-functions for E1, M1, and E2 transitions; and codes developed to compute large, discrete, nuclear level sets, their associated gamma-ray branchings, and the presence and location of isomeric states. 7 refs., 2 figs.

48485 Report on the Oak Ridge workshop on Monte Carlo codes for relativistic heavy-ion collisions. Awes, T.C. (Oak Ridge National Lab., TN (USA)); Sorensen, S.P. *Nuclear Physics [Section] A (Netherlands)*, 498: 498 (10 Jul 1989). DOE Contract AC05-84OR21400. (CONF-8809203–: Quark Matter '88: 7th international conference on ultrarelativistic nucleus-nucleus collisions, Lenox, MA (USA), 26-30 Sep 1988).

Nine different Monte Carlo codes for relativistic nucleus-nucleus collisions were represented at the workshop. These include ATTILA and FRITIOF based on the LUND string picture of hadron-hadron interactions. Three other models based on a string picture of hadron-hadron interactions were also presented at the workshop. These were IRIS, MCFM, and VENUS, all of which are 'color exchange models' based on the Dual Parton Model (DPM) of Capella et al. Other models represented at the workshop included HIJET,

which is an extension of the ISAJET model of hadron interactions, and MACRO, which is based upon a phenomenological parametrization of nucleon-nucleon collisions and which emphasizes the problem of nuclear stopping. Two other models represented at the workshop with quite different approaches were the HICOL and RQMD models. (orig./HSI).

48486 Pion interferometry of O+Au at 200 AGeV. Padula, S.S. (Lawrence Berkeley Lab., CA (USA)); Gyulassy, M. *Nuclear Physics [Section] A (Netherlands)*, 498: 498 (10 Jul 1989). DOE Contract AC03-76SF00098. (CONF-8809203–: Quark Matter '88: 7th international conference on ultrarelativistic nucleus-nucleus collisions, Lenox, MA (USA), 26-30 Sep 1988).

We analyse NA35 data on O+Au->$\pi^-\pi^-$+X at 200 A GeV including resonance decays and non-ideal dynamical and geometrical effects and find that a tau_f=$R_{perpendicular\ tof}$=4 fm chaotic source is consistent with the data. (orig.).

6540 Radiation and Shielding Physics

48487 (ANL/NDM–113) **Resonance effects in neutron scattering lengths.** Nuclear Data and Measurements Series. Lynn, J.E. Argonne National Lab., IL (USA). Jun 1989. 19p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE89017897/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The nature of neutron scattering lengths is described and the nuclear effects giving rise to their variation is discussed. Some examples of the shortcomings of the available nuclear data base, particularly for heavy nuclei, are given. Methods are presented for improving this data base, in particular for obtaining the energy variation of the complex coherent scattering length from long to sub-Å wave lengths from the available sources of slow neutron cross section data. Examples of this information are given for several of the rare earth nuclides. Some examples of the effect of resonances in neutron reflection and diffraction are discussed. This report documents a seminar given at Argonne National Laboratory in March 1989. 18 refs., 18 figs.

48488 (CEA-N–2599) **Domain decomposition method for solving the neutron diffusion equation.** Coulomb, F. CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France). Mar 1989. 28p. (In French). Order Number DE90701451/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

The aim of this work is to study methods for solving the neutron diffusion equation; we are interested in methods based on a classical finite element discretization and well suited for use on parallel computers. Domain decomposition methods seem to answer this preoccupation. This study deals with a decomposition of the domain. A theoretical study is carried out for Lagrange finite elements and some examples are given; in the case of mixed dual finite elements, the study is based on examples.

48489 (INIS-mf–11514, pp. 353-358) **Development of electron-photon cascades in lead and layers of lead-scintillator.** Wasilewski, A. (Lodz Univ. (Poland). Inst. Fizyki); Krys, E. Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985*. Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

The investigation of electromagnetic cascades in lead and lead-scintillator calorimeter which are often used in emulsion chamber experiments are presented. The investigations were performed by analysis of the cascades using the Monte Carlo method. The simulations were based on the detailed modelling of a three-dimensional propagation of particles allowing for all processes in which particles may participate. 2 refs., 5 figs., 2 tabs. (M.F.W.).

48490 (INS-T–487) **Easy method of a neutron skyshine calculation and its application to the Japanese Hadron Project.** Sato, Shingo; Uwamino, Yoshitomo; Shibata, Tokushi. Tokyo Univ., Tanashi (Japan). Inst. for Nuclear Study. Jan 1989. 35p. (In Japanese). Order Number DE90701779/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

A thick radiation shield makes neutrons into a 1/E spectrum and an isotropic angular distribution. In this case, if the maximum neutron energy and the dose rate distribution on the roof of a nuclear facility are known, all the source parameters of skyshine neutrons can be fixed. In this study, a skyshine kernel between a dose distribution on a facility roof and an environmental dose distribution was obtained by using the Nakamura-Kosako formula. A skyshine calculation using this kernel agreed well with the measurement in a case of a 14MeV neutron source facility. The Moyer model gives the dose rate distribution on the soil surface of the synchrotron and the beam dump of the Japanese Hadron Project, and the Neutron skyshine was evaluated with this kernel for several parameter sets of the facility. (author).

48491 (ORNL/TM–10568) **DABL69: A broad-group neutron/photon cross-section library for defense nuclear applications.** Ingersoll, D.T.; Roussin, R.W.; Fu, C.Y.; White, J.E. Oak Ridge National Lab., TN (USA). Jun 1989. 45p. Sponsored by U.S. Department of Defense. DOE Contract AC05-84OR21400. Order Number DE89015658/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A new multigroup cross-section library has been generated from ENDF/B-V data for use in defense-related radiation shielding applications. The library is available in a broad-group (46-neutron, 23-photon) energy structure and is designated DABL69. The establishment of specifications for the library, especially the specific group structure and energy weighting functions, was an important part of the generation of the library. The energy group structure contains some special tailoring to the oxygen and nitrogen cross sections and improved energy resolution in the range of 100-1000 keV where the iron cross section is highly structured. The library contains most materials of importance in defense-related shielding problems and includes several reference source spectra and response functions. The library is available in two formats including the commonly used ANISN format and the more versatile AMPX master format. 19 refs., 8 figs., 10 tabs.

6550 Medical Physics

Refer also to citation(s) 47143

48492 (CSIR-RR–599) **Standardization of ^{67}Ga by liquid scintillation coincidence counting.** Simpson, B.R.S.; Meyer, B.R. Council for Scientific and Industrial Research, Pretoria (South Africa). 1987. 21p. Available from the National Accelerator Centre, Council for Scientific and Industrial Research, PO Box 72, Faure, 7131, South Africa.

A solution of ^{67}Ga has been standardized, using measuring techniques developed previously at the National Physical Research Laboratory. An ampoule containing a sample of the solution was sent to the Bureau International des Poids et Mesures for comparative measurement. The registration table and a plot based thereon are presented. The intensity of the internal conversion electrons from the 93 keV excited state has been measured as 0.311+-0.005. 9 figs., 6 tabs., 8 refs.

48493 (KURRI-TR–314) **Records of radiation control division, 24 (1987).** Iwamoto, Satoshi (ed.); Ishida, M.R.; Kikuchi, Tadatoshi (and others). Kyoto Univ., Kumatori, Osaka (Japan). Research Reactor Inst. Mar 1989. 45p. (In Japanese). Order Number DE90701780/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

This report is the summary of the activity of the Division Of Radiation Control on the safety management in FY 1987 (April 1987-March 1988). This report describes the records of the radiation control tasks by the three sections of the Division, Indoor Radiation Control, Field Radiation Control and Personnel Radiation Control. External doses an radio-activity concentrations in the water and air were monitored continuously and the data were acquired. Report on the meteorological data and the environmental radioactive concentration are described. In this repots, a number of unscheduled tasks, are also described. The records of the control of

personnel radiation exposure and the education to new staffs of the institute and researchers were described. (author).

6560 Condensed Matter Physics

Refer also to citation(s) 47333, 47359, 47379, 47399, 47442, 48530, 48579

48494 (AD-A-206734/6/XAB) **Studies on ions and neutrals desorbed from solid surfaces by ion and electron bombardment. Final report, 1 November 1984-31 October 1988.** Winograd, N. Pennsylvania State Univ., University Park, PA (USA). Dept. of Chemistry. 24 Mar 1989. 23p. Available from NTIS, PC A03/MF A01.

This project was aimed toward increasing our fundamental knowledge of the details of the interaction of energetic particles with solid surfaces. These studies included the measurement of the angular and energy contributions of the yield of desorbed ions by secondary ion mass spectrometry (SIMS). In addition, a novel angle- and energy-resolved detector was developed, capable of measuring for the first time the yield of neutral particles desorbed from monolayers. This detector utilized multi-photon resonance ionization of the ejected atoms which occur at efficiencies approaching 100%. The results of the experimental measurements were coupled to classical-dynamics calculations of the ion impact event. This approach was pursued to utilize ion beams to examine the structure of surface layers through anisotropies observed in the angular distributions. A variety of materials including alloys, semiconductors and organic monolayers on metals were candidates as model systems. The experiments have opened new avenues for using ion-beam methods for the trace analysis of important electronic materials at unprecedented sensitivity.

48495 (AD-A-207734/5/XAB) **Chemical effects of Ne(+) bombardment on the MoS_2(0001) surface studied by high-resolution photoelectron spectroscopy. Technical report.** Lince, J.R.; Stewart, T.B.; Hills, M.M.; Fleischauer, P.D.; Yarmoff, J.A. Aerospace Corp., El Segundo, CA (USA). Chemistry and Physics Lab. 28 Mar 1989. 36p. (TR-0088(3945-03)-2). Available from NTIS, PC A03/MF A01.

The effect of 1-keV neon-cation bombardment on the clean Molybdenum disulfide (0001) - 1 x 1 surface with fluences between 4 x 10^{14} Ne(+)/sq. cm was studied using high-resolution photoelectron spectroscopy excited with synchrotron radiation. Spectra of the Mo-3d and S-2p core levels were measured with photon energies that ensured that the kinetic energy of their photoelectrons was the same, resulting in the same depth being probed for both core levels. For lower fluences, S vacancy defect formation occurs in the MoS_2 lattice, with the concurrent formation of a small amount (<10%) of dispersed elemental molybdenum Mo(0). For fluences greater than approx. 1 x 10^{16} Ne(+)/sq. cm, the Mo(0) is the predominant species in the surface region, while the remaining species consists of amorphous MoS(2-x)and polysulfide species. Valence band spectra taken with photon energies of 152 eV and 225 eV were consistent with the core-level results. The movement of the valence band maximum toward the Fermi level indicated the formation of a metallic surface region. A qualitative depth distribution of the chemical species present after Ne(+) bombardment was determined. Results indicate that the preferential sputtering of sulfur over molybdenum occurs predominantly through a mechanism involving chemical-bonding effects, specifically, through the preferential emission of polysulfide ions over other species in the bombarded region.

48496 (BNL-42810) **Spin fluctuations and excitations in a 2D xy-ferromagnet: CoClsub 2 in graphite.** Wiesler, D.G.; Zabel, H. Brookhaven National Lab., Upton, NY (USA). 1989. 7p. Sponsored by DOE/ER;NSF. DOE Contract AC02-76CH00016. (CONF-890519-1: 5. international symposium on graphite intercalation compounds, Berlin (Germany, F.R.), 22-25 May 1989). Order Number DE89017600/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

We have investigated by neutron scattering the spin fluctuations and excitations in the stage 2 $CoCl_2$ – graphite intercalation compound. This compound has easy-plane anisotropy and sufficiently weak interplanar interaction to qualify as a test material for Kosterlitz-Thouless-Berezinsky type phase transitions. We have carried out quasi-elastic scattering measurements to determine the temperature variation of the spin correlation length ξ above the two dimensional ordering transition. We have also probed the dependence on wave vector and temperature of the inelastic scattering cross section, consisting of both a central peak, associated with vortex diffusion, and spin wave, which become strongly damped above the transition temperature. 15 refs., 5 figs.

48497 (CONF-890821-3) **Anomalous ion-channeling behavior across the superconducting transition in high-T_c materials.** Rehn, L.E.; Sharma, R.P.; Baldo, P.M.; Liu, J.Z. Argonne National Lab., IL (USA). Jul 1989. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. From 13. international conference on atomic collisions in solids; Aarhus (Denmark); 7-11 Aug 1989. Order Number DE89017677/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Axial channeling scans with minimum RBS yields of $\leq$2% were obtained for 1.5 MeV ^{4}He ions incident along the c-axis in $YBa_2Cu_3O_{7-\delta}$ and $ErBa_2Cu_3O_{7-\delta}$ single crystals. Large variations in the FWHM of the (001) channeling dip were observed for temperatures between 30 and 300 K. An abrupt, ~8% increase was measured as the temperature was lowered through the superconducting transition (T_c); the relative increase across T_c in the width of the axial dip was even larger for angles of incidence less than the critical angle. A simple analytical procedure for polyatomic materials yields isotropic, average thermal vibrational amplitudes that agree well with considerably less precise neutron powder diffraction results on sintered samples. The individual contribution to the angular channeling dip from the row of Er and Ba atoms parallel to the c-axis can be isolated in the RBS scans of the Er compound. This separation reveals normal (Debye-type) behavior for atoms in the Er-Ba row, demonstrating that the anomalous changes are due solely to atomic displacements in the Cu-O row. Finally, x-ray studies using specimens with different O stoichiometries reveal that the anomalous change in the FWHM shifts in temperature in direct proportion to the change in T_c.

48498 (DOE/ER/13821-2) **Complex temporal and spatial patterns in nonequilibrium systems: Progress report, December 1, 1988–November 30, 1989.** Swinney, H.L. Texas Univ., Austin, TX (USA). Dept. of Physics. Sep 1989. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract FG05-88ER13821. Order Number DE89017809/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Dynamical systems methods are being developed and used to characterize nonequilibrium processes and to address outstanding unresolved questions regarding bifurcations and chaos in both homogeneous and spatially extended systems. An information theoretic property, the redundancy, is found to yield a quantitative criterion for the reconstruction of phase space portraits from time series, and this criterion is, at least in some cases, superior to criteria deduced from singular value decomposition analyses. Experiments on complex bifurcation sequences and chaos in well-stirred chemical reactions show that dynamical systems tools can provide insight into chemical mechanisms. Experiments and numerical simulations on electrodeposition clusters reveal an asymptotic self-similar regime in which the generalized dimensions D_q are independent of q, equal to 1.6 $\pm$ 0.1. Spatial patterns in Rayleigh-Benard convection near onset have been studied numerically and analytically, and conditions have been found for which the patterns are hexagons rather than rolls. These laboratory experiments and numerical and analytic studies of models should provide general insights into the behavior of nonequilibrium systems.

48499 (IC-88/370) **Non Newtonian gravity creeping flow.** Gratton, J.; Mahajan, S.M.; Minotti, F. International Centre for Theoretical Physics, Trieste (Italy). Nov 1988. 18p. Order Number DE90600816/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

We derive the governing equations for creeping gravity currents of non Newtonian liquids having a power law rheology, using a lubrication approximation. We consider unidirectional and axisymmetric currents. The equations differ from those for Newtonian liquids, being nonlinear in the spatial derivative of the thickness of the current. However, many solutions are closely analogous to

those for Newtonian rheology; in particular the spreading relations can also be expressed as power laws of time, with exponents that depend on the rheological index. Similarity solutions for currents whose volume varies as a power of time are obtained. For the spread of a constant volume of liquid, analytic solutions are found. We also derive solutions of the waiting-time type, as well as the ones describing steady flows from a constant source to a sink. General travelling wave solutions are given, and analytic formulae for a simple case are derived. A phase plane formalism, that allows the systematic derivation of self similar solutions, is introduced. The application of the Boltzmann transform is briefly discussed. Present results are closely analogous to those for Newtonian liquids; all the solutions obtained here have their counterparts in Newtonian flows. This happens because the power law rheology, like the Newtonian constitutive relation, involves a single dimensional parameter. Thus one finds similarity solutions whenever the analogous Newtonian problem is self similar. Although the spreading relations are rheology-dependent, in most cases the dependence is rather weak. The present results may be of interest for geophysics since the lithosphere deforms according to an average power law rheology. (author). 17 refs.

48500 (IC–89/69) **Structure properties of confined systems. Hard spheres between ideal walls.** Boudh-hir, M.E. International Centre for Theoretical Physics, Trieste (Italy). May 1989. 17p. Order Number DE90600818/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

An iterative development of the one-particle distribution function, for hard sphere fluids confined between two parallel ideal walls, is proposed. This development allows us to study the confinement effect. It is shown that the confinement has two components. The first, which remains even when the superposition approximation is used, is called compatibility term. The second, due to the fact that the particles may be correlated to the two walls simultaneously, is referred to as coupling term. The latter disappears when the superposition approximation is introduced. These two terms have different magnitudes and ranges. They are governed by the parameters, L, the distance between the walls along which the particles are free to move, σ, the hard sphere diameter; and, eta, the packing fraction of the fluid. (author). 17 refs, 2 figs.

48501 (IC–89/113) **Fractal dimension of a quasi-two-dimensional Sierpinski gasket as a conductor.** Tian Decheng; Peng Gongwen. International Centre for Theoretical Physics, Trieste (Italy). Jun 1989. 11p. Order Number DE90600817/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

It is shown that the fractal dimension of Sierpinski gasket as a conductor is different from that for its geometry. The fractal dimension of Sierpinski gasket can be defined as $D = D_E + iD_R$. D_E and D_R are the fractal dimensions determined from its conductance and resistance, respectively. For 2-d Sierpinski gasket $D_R = 3.8$ and $D_E = 1/D_R = 0.263$, while for 3-d Sierpinski tetrahedron $D_R = 2.41$ and $D_E = 0.415$. (author). 4 refs, 5 figs.

48502 (INIS-mf–11537, pp. 30) **Spectroscopic measurements of the energy of sputtered copper atoms.** Turner, G.M. (Sydney Univ. (Australia). Dept. of Plasma Physics); Falconer, I.S.; James, B.W.; McKenzie, D.R. Australian Inst. of Nuclear Science and Engineering, Lucas Heights (Australia). 1989. (CONF-8902130–: 17. AINSE plasma physics conference, Lucas Heights (Australia), 6-8 Feb 1989). In *17th AINSE plasma physics conference: conference handbook.* Order Number DE90600936/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

'Short communication.'

48503 (INIS-mf–11537, pp. 32) **Effects of plasma confinement on deposition and etch rates.** Davies, K.E. (New South Wales Univ., Kensington (Australia). School of Electrical Engineering); Horwitz, C.M. Australian Inst. of Nuclear Science and Engineering, Lucas Heights (Australia). 1989. (CONF-8902130–: 17. AINSE plasma physics conference, Lucas Heights (Australia), 6-8 Feb 1989). In *17th AINSE plasma physics conference: conference handbook.* Order Number DE90600936/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

Abstract only.

48504 (INIS-mf–11537, pp. 33) **Ion bombardment in radio-frequency glow discharges.** Smith, A.M. (New South Wales Univ., Kensington (Australia). School of Electrical Engineering); Horwitz, C.M. Australian Inst. of Nuclear Science and Engineering, Lucas Heights (Australia). 1989. (CONF-8902130–: 17. AINSE plasma physics conference, Lucas Heights (Australia), 6-8 Feb 1989). In *17th AINSE plasma physics conference: conference handbook.* Order Number DE90600936/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

Abstract only.

48505 (INIS-mf–11537, pp. 53) **Fast anisotropic etching of silicon by SF_6 in an inductively coupled plasma reactor.** Perry, A.J. (Australian National Univ., Canberra (Australia). Plasma Research Lab.); Boswell, R.W.; Emami, M. Australian Inst. of Nuclear Science and Engineering, Lucas Heights (Australia). 1989. (CONF-8902130–: 17. AINSE plasma physics conference, Lucas Heights (Australia), 6-8 Feb 1989). In *17th AINSE plasma physics conference: conference handbook.* Order Number DE90600936/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

Abstract only.

48506 (INIS-mf–11537, pp. 65) **Plasma etching of photoresist materials for microelectronic applications.** Gross, M. (New South Wales Univ., Kensington (Australia). School of Electrical Engineering); Horwitz, C.M. Australian Inst. of Nuclear Science and Engineering, Lucas Heights (Australia). 1989. (CONF-8902130–: 17. AINSE plasma physics conference, Lucas Heights (Australia), 6-8 Feb 1989). In *17th AINSE plasma physics conference: conference handbook.* Order Number DE90600936/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

Abstract only.

48507 (INIS-SU–107/A, pp. 189) **EPR spectra peculiarities of $Y_1Ba_2Cu_3O_{7-x}$ system.** Maksimov, N.G. (AN SSSR, Krasnoyarsk. Inst. Khimii i Khimicheskoj Tekhnologii); Shklyaev, A.A.; Volkov, V.E.; Kovalev, Yu.G. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.

'Short Communication.'

48508 (INIS-SU–107/A, pp. 165) **Absorption jump mechanism of EPR in WO_3, MoO_3 compounds of heteropolyanion type.** Shirokov, M.I. (Latvijskij Gosudarstvennyj Univ., Riga. (USSR). Nauchno-Issledovatel'skij Inst. Fiziki Tverdogo Tela). AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.

'Short Communication.'

48509 (INIS-SU–107/A, pp. 164) **Radiation-induced paramagnetic centers in quartz blanks of optical waveguides.** Shendrik, A.V. (Latvijskij Gosudarstvennyj Univ., Riga. (USSR). Nauchno-Issledovatel'skij Inst. Fiziki Tverdogo Tela). AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of

coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
'Short Communication.'

48510 (INIS-SU–107/A, pp. 208) **Investigation of erbium containing glass structure by EPR method.** Kovchur, S.G. (Vitebskij Tekhnologicheskij Inst. Legkoj Promyshlennosti (Byelorussian SSR)); Fedorova, V.A. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
'Short Communication.'

48511 (INIS-SU–107/A, pp. 229) **Radiospectroscopic detection of zirconium silicate defectness.** Derskij, L.S. (AN Ukrainskoj SSR, Kiev (Ukrainian SSR). Inst. Geokhimii i Fiziki Mineralov); Proshko, V.Ya.; Kalinichenko, A.M.; Brik, A.B. AN SSSR, Moscow (USSR); Ministerstvo Vysshego i Srednego Spetsial'nogo Obrazovaniya RSFSR, Moscow (USSR); AN SSSR, Moscow (USSR). Nauchnyj Sovet po Neorganicheskoj Khimii; AN SSSR, Moscow (USSR). Inst. Obshchej i Neorganicheskoj Khimii; Kubanskij Gosudarstvennyj Univ., Krasnodar (USSR). 1988. (In Russian). (CONF-8810413–: 5. All-Union conference on spectroscopy of coordination compounds, Krasnodar (USSR), 5 Oct 1988). In *5. All-union conference on spectroscopy of coordination compounds. Summaries of reports.* Order Number DE89012208/JAW. Available from NTIS (US Sales Only), PC A15/MF A01; INIS.
'Short Communication.'

48512 (INIS-SU–112, pp. 3-6) **Atomic displacement distribu< on during ion irradiation.** Babaev, V.P. (AN SSSR, Moscow (USSR). Inst. Metallurgii); Zabolotnyj, V.T.; Mel'nikiv, V.N.; Bobkov, A.F.; Zajtsev, S.V.; Suvorov, A.L. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Tsentral'nyj Nauchno-Issledovatel'skij Inst. Informatsii i Tekhniko-Ehkonomicheskikh Issledovanij po Atomnoj Nauke i Tekhnike. 1988. (In Russian). (BTs–23145). In *Physics of radiation damages and radiation material science. Scientific-technical collection.* Order Number DE89018004/JAW. Available from NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS.
Voprosy atomnoj nauki i tekhniki.; v. 5(47).
The method to plot atomic displacement distribution in depth of solids irradiated by ions is suggested. This method leads to better agreement between measured dependences of displacement density on the depth and the sputtering factor per shooting on the target thickness in comparing with the known theory of linear cascades. The experimental results given in the paper and obtained for tungsten irradiated by iron ions (5 keV energy) are in satisfactorily agreement with theoretical data calculated according to the method suggested. 9 refs.; 2 figs.; 1 tab.

48513 (INIS-SU–112, pp. 11-14) **Transmutation process simulation in silicon during mean energy proton irradiation.** Mushnikov, V.N. (AN Ukrainskoj SSR, Kharkov (Ukrainian SSR). Fiziko-Tekhnicheskij Inst.); Khizhnyak, N.A.; Shilyaev, B.A.; Neklyudov, I.M.; Ozhigov, L.S.; Klyukovich, V.A.; Levchuk, L.G. Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow (USSR). Tsentral'nyj Nauchno-Issledovatel'skij Inst. Informatsii i Tekhniko-Ehkonomicheskikh Issledovanij po Atomnoj Nauke i Tekhnike. 1988. (In Russian). (BTs–23145). In *Physics of radiation damages and radiation material science. Scientific-technical collection.* Order Number DE89018004/JAW. Available from NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS.
Voprosy atomnoj nauki i tekhniki.; v. 5(47).
Nuclear transmutation processes during silicon irradiation by 100 MeV protons are studied. The results of calculations can be used when choosing radiation parameters in the method of nuclear alloying of semiconductor materials by mean energy proton beams. 12 refs.; 6 figs.

48514 (INIS-SU–113/A, pp. 17-19) **Change of p-n junction photoelectric properties during semiconductor transition in to ferroelectric phase.** Grishechkina, S.P.; Lupu, A.T. AN SSSR, Moscow (USSR). Fizicheskij Inst. 1989. (In Russian). (T–23539). In *Experimental and theoretical physics. Collection.* Order Number DE89018003/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.
Kratkie soobshcheniya po fizike.; v. 1.
Photoelectric properties of p-n junctions in a ferroelectric phase are studied. It is detected that at the temperatures below the temperature of ferroelectric phase transition (T_c) a change in photo e.m.f. sign takes place, which is accompanied by the appearance of a narrow maximum on thelong-wave edge of photoconductivity spectrum and a maximum in the temperature behaviour of the capacity. A model of the p-n junction, taking into account the screening of spontaneous polarization, is provided for the interpretation of the regularities observed. 6 refs.; 3 figs.

48515 (IPP–6/277) **Lyapunov stability of large systems of van der Pol-like oscillators and connection with statistics and turbulence.** Tasso, H. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Oct 1988. 12p. (CONF-8809373–: 3. international workshop on mathematical aspects of fluid and plasma dynamics, Salice Terme (Italy), 26-30 Sep 1988). Order Number DE90702888/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.
For a system of van der Pol-like oscillators, Lyapunov functions valid in the greater part of phase space are given. They allow a finite region of attraction to be defined. Any attractor has to be within the rigorously estimated bounds. Under a special choice of the interaction matrices the attractive region can be squeezed to zero. In this case the asymptotic behaviour is given by a conservative system of nonlinear oscillators which acts as attractor. Though this system does not possess in general a Hamiltonian formulation, Gibbs statistics is possible due to the proof of a Liouville theorem and the existence of a positive invariant or 'shell' condition. The 'canonical' distribution of the attractor is remarkably simple despite nonlinearities. Finally the connection of the van der Pol-like system and of the attractive region with turbulence problems in fluids and plasmas is discussed. (orig.).

48516 (IPPJ–895) **Secondary electron emission from a metal surface bombarded by slow multiply charged ions.** Ohtani, S.; Oda, K.; Ichimiya, A.; Takagi, S.; Tawara, H.; Yasue, Y. Nagoya Univ. (Japan). Inst. of Plasma Physics. Dec 1988. 19p. Order Number DE90701582/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.
Pulse height distributions of a microchannel plate (MCP) for impact of slow multiply charged ions have been measured. It was observed that a relative gain of the MCP increases with an increase of the charge state of incident ions. Such gain characteristics are discussed in connection with secondary electron emission yield at the input of the MCP. Next, absolute values of electron emission yield γ for impact of Ar^{q+} (q=1-8) on a polycrystalline tantalum and gold surface have been measured. The values of γ are nearly proportional to the total potential (neutralization) energy of the incident ions. (author).

48517 (IPPJ–901) **Solid-vapor differences of electronic stopping powers for protons.** Kaneko, Toshiaki. Nagoya Univ. (Japan). Inst. of Plasma Physics. Mar 1989. 24p. Order Number DE90701758/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.
By applying the recently-developed wave packet theory and the Lindhard-Winther (LW) theory to estimation of the stopping powers of bound electrons and conduction electrons, respectively, the solid-vapor differences in the electronic stopping of target materials for protons are estimated quantitatively over the energy range from 1 keV/amu to 10 MeV/amu. Here, comparison was made of current theoretical predictions with each other. The wave packet theory shows that the solid-vapor difference of stopping cross sections are

enhanced for low-energy protons because of the binding effect. (author).

48518 (LA-UR–89-2324) **High pressure ^{129}I Moessbauer studies of GeI_4 molecular crystals.** Pasternak, M.P.; Taylor, R.D. Los Alamos National Lab., NM (USA). [1989]. 12p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-36. (CONF-890933–1: International conference on the applications of the Mossbauer effect (ICAME '89), Budapest (Hungary), 4-8 Sep 1989). Order Number DE89015269/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The Moessbauer effect in ^{129}I in conjunction with Diamond-Anvil-Cell high pressure techniques was applied to investigate the high pressure phase(s) of the molecular crystal GeI_4. The ^{129}I Quadrupole Interaction was the main probe for characterizing the intermolecular structural transformation with pressure. With increasing pressure, at about 15 GPAa, the onset of a partial molecular-association phase (HP1) is first observed. In HP1 two out of the four iodines strongly overlap to form linear chains of GeI_4. The HP1 phase coexists with the low pressure (LP) molecular phase, but its population increases with increasing pressure. At P $\approx$20 GPa a second high pressure phase (HP2) is identified where all four iodines strongly overlap to form a three dimensional, fully molecular-associated structure. With increasing pressure and at P > 20 GPa, HP2 is the only phase up to P = 34 GPa, the highest pressure used. A significant hysteresis of the relative abundances with pressure is observed. The isomer shift of the HP2 and HP1 structures is considerably larger than that of the LP one. 11 refs., 3 figs.

48519 (LA-UR–89-2718) **Shock-induced reaction in several liquids.** Sheffield, S.A.; Alcon, R.R. Los Alamos National Lab., NM (USA). [1989]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-890812–23: American Physical Society topical conference on shock compression of condensed matter, Albuquerque, NM (USA), 14-17 Aug 1989). Order Number DE89016594/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Single-shock experiments have been completed in several liquids using multiple, embedded, electromagnetic Lagrangian particle velocity and impulse gauges to measure shock waveforms. The liquids include acrylonitrile, bromoform, diiodomethane, phenylacetylene, bromocyclopropane, and carbon disulfide. Some of these are known to exhibit shock-induced reaction and others are considered to be candidates for reaction studies. The "universal" liquid Hugoniot, which depends only on initial condition sound speed, was used to calculate the unreacted Hugoniot. Sound velocities were measured for those liquids with no data available. The effects of shock-induced reaction are clearly identified in the particle velocity waveforms for some materials, but there are remaining questions about whether reactions occur in others. The most impressive results are that the full reactive, two-wave structure was measured in phenylacetylene. On the reacting materials with two-wave structures, the particle velocity waveforms had a decrease behind the top of the first wave. This is thought to be evidence of an early reaction which occurs at the top of the first (nonreactive) wave. 12 refs., 2 figs., 1 tab.

48520 (ORNL/FTR–3281) **[Atomic physics with large electrostatic accelerators]: Foreign trip report, May 14, 1989–June 9, 1989.** Datz, S. Oak Ridge National Lab., TN (USA). 12 Jun 1989. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017479/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler attended the First International Symposium on Swift Heavy Ions in Matter (SHIM '89) in Caen, France, and presented a paper on "Dielectronic and Direct Excitation of Channeled Ions." He then participated in the 5th International Conference on Electrostatic Accelerators and Associated Boosters (Strasbourg, France, and Heidelberg, West Germany) and presented an invited lecture on "Atomic Physics with Large Electrostatic Accelerators." The traveler visited the University of Aarhus (Denmark), where discussions were held on the present status of ASTRID; forthcoming collaborative experiments at CERN; dielectronic and radiative recombination experiments; charge dependence of double excitation and excitation-ionization collisions in helium; and crystal preparation for ORNL experiments in channeling.

48521 (ORNL/FTR–3308) **[Ion beam deposition of epitaxial germanium and gallium arsenide layers]: Foreign trip report, June 2, 1989–June 18, 1989.** Haynes, T.E. Oak Ridge National Lab., TN (USA). 5 Jul 1989. 23p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017439/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler presented an invited paper entitled "Ion Beam Deposition of Epitaxial Germanium and Gallium Arsenide Layers" at the Twelfth Symposium on Ion Sources and Ion-Assisted Technology (ISIAT '89) in Tokyo. During informal conversations at this meeting, the traveler was informed about a new Japanese initiative, sponsored by the Ministry of International Trade and Industry and an industrial consortium, to establish an Ion Engineering Research Center, whose purpose will be to provide sophisticated equipment and technology base for exploring and developing new applications of ion beam processing. The traveler also visited five Japanese laboratories involved in research on ion-solid interactions. Developments in ionized cluster beam (ICB) deposition were emphasized at ISIAT '89 and during visits to Kyoto University, where the ICB technique was pioneered, and to Mitsubishi Electric's Itami Works, where commercial ICB systems are now being produced. Discussions at Osaka University concentrated on the application of focused ion beams for maskless patterning of submicron devices and on recent studies of one- dimensional quantum effects in semiconductor wires. At Hitachi Research Laboratory, basic research on thin-film growth was described, as well as progress toward the development of a variable frequency RF quadrupole accelerator for ion implantation. Researchers at JAERI outlined programs in characterization and thin-film deposition of superconductors and in materials science studies using high-energy ion beams.

48522 (SAND–88-3307C) **Hydrogen-assisted thermal donor formation in silicon.** Stein, H.J.; Hahn, S. Sandia National Labs., Albuquerque, NM (USA); Siltec Silicon, Menlo Park, CA (USA). 1989. 10p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-890946–1: 3. meeting on defect recognition and image processing in semiconductors (DRIP-3), Yokohama (Japan), 17-22 Sep 1989). Order Number DE89016809/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Energetic hydrogen or deuterium ions from a plasma can increase the thermal donor, TD, formation rate in Czochralski Si at 400°C by more than an order of magnitude above that for exposure in H_2 or in a He plasma. Infrared absorption techniques were used to identify the donors, and donors concentrations and penetration depths were determined from spreading resistance probe measurements. The concentration and penetration depth for hydrogen-assisted TD formation are dependent upon the annealing history. Hydrogen-assisted formation rates can extend through a 0.5 mm depth of an as-grown wafer, whereas the hydrogen-assisted rate decreases markedly with depth when the plasma exposure occurs after a rapid thermal anneal cycle at 850°C. Hydrogen-assisted TD formation is attributed to H(deuterium) diffusion and catalyzed conversion of oxygen-related nuclei to TD's in as-grown Si. Hydrogen-assisted regrowth of nuclei is suggested for the rate-limiting step in TD formation after a rapid thermal anneal cycle. Assisted TD formation in a hydrogen-plasma was observed beyond a buried oxide layer in Si, but not beyond a buried nitride layer which is consistent with relative hydrogen diffusivities in SiO_2 and silicon nitride.

48523 (SAND–89-1875C) **Energy relaxation of light holes in $InAs_{.15}Sb_{.85}$/InSb multiple quantum wells.** Tigges, C.P.; Schirber, J.E.; Hjalmarson, H.P.; Fritz, I.J.; Dawson, L.R. Sandia National Labs., Albuquerque, NM (USA). [1989]. 9p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-8907133–1: 6. international conference on hot carriers in semiconductors, Scottsdale, AZ (USA), 23-28 Jul 1989). Order Number DE89016035/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The energy relaxation rate of light in-plane in $InAs_{.15}Sb_{.85}$/InSb quantum wells has been measured using a Shubnikov-de Haas technique. In this Type II system, the holes reside in the InSb layers; strain reverses the heavy-light hole ordering and thus light holes are the charge carriers. The samples consist of 20 to 100

$InAs_{.15}Sb_{.85}$/InSb periods 100Å/200Å thick. The InAsSb barriers are doped with Be. The total carrier concentration is obtained from Hall data. Shubnikov-de Haas oscillation amplitudes are measured and used to determine the light hole temperature for a given applied power. The steady state power per carrier is equated to the energy relaxation rate to determine the carrier temperature T_H. Data are compared with theory and experiment for light holes in InGaAs/GaAs quantum wells. 17 refs., 5 figs.

48524 (UCRL–100804) **Calculation of the refractive index change in dissociating shocked benzene.** Erskine, D.J. Lawrence Livermore National Lab., CA (USA). Aug 1989. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890812–42: American Physical Society topical conference on shock compression of condensed matter, Albuquerque, NM (USA), 14-17 Aug 1989). Order Number DE89017737/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A calculation is made of the refractive index (n) of a shocked solution of hydrocarbon species and spheroidal carbon particles that would be the dissociation products of benzene. The result is evaluated for benzene shocked to 15 GPa or particles of different morphologies. In the case of diamond particles, the refractive index is predicted to decrease through the dissociation from 1.96 to 1.75. For particles of graphite in platelet form (10:1 aspect ratio) the refractive index increases from 1.96 to 2.2. Thus the measurement of n(t) could indicate the morphology of the carbon particulates and the time scale for this reaction, as well as the instantaneous amount of carbon particulate. The latter information is valuable in conjunction with recent Mie scattering experiments for example. 7 refs., 4 figs.

48525 (UCRL–101616) **A rate-dependent constitutive model for Be.** Steinberg, D.J. Lawrence Livermore National Lab., CA (USA). Jul 1989. 4p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890812–45: American Physical Society topical conference on shock compression of condensed matter, Albuquerque, NM (USA), 14-17 Aug 1989). Order Number DE89017755/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The Steinberg-Guinan-Lund rate-dependent constitutive model for BCC metals has been extended to the HCP metal Be. Computer simulations with this model correctly predict a number of time-resolved shock-wave experiments. However, the model does not reproduce all the yield strength data at low strain-rates. These discrepancies could be due to the different material properties in the different experiments, or simply to limitations of the model. 16 refs., 8 figs.

48526 Pseudopotential calculations of structural properties of solids. Cohen, M.L. (Dept. of Physics, Univ. of California, and Materials and Molecular Research Div., Lawrence Berkeley Lab., Berkeley, CA (US)). vp of Computer-based microscopic description of the structure and properties of materials. Broughton, J.; Krakow, W.; Pantelides, S.T. Materials Research Society, Pittsburgh, PA (1986). (CONF-851217–: Materials Research Society meeting, Boston, MA (USA), 2-7 Dec 1985).

Through the development of a total energy pseudopotential approach, it has become possible to compute structural, electronic, and vibrational properties of solids using only the atomic numbers and atomic masses of the constituent atoms as input. The method has been applied to semiconductors, insulators, and metals; and agreement with experiment for most properties is usually within a few percent. Applications include the determination of lattice constants for specific structural phases, properties of structural phase transitions, cohesive energies, bulk moduli, lattice vibrational spectra, electron-lattice interaction parameters, and electronic and superconducting properties. A recent example is the prediction of superconductivity in highly condensed hexagonal silicon which was subsequently found experimentally.

48527 Electron density fluctuations induced by ion clusters in condensed matter. Pitarke, J.M. (Universidad del Pais Vasco, Bilbao (Spain). Facultad de Ciencias); Echenique, P.M.; Ritchie, R.H. *Nuclear Instruments and Methods in Physics Research, Section B: Beam Interactions with Materials and Atoms (Netherlands)*, 40/41(pt.1): 333-339 (Apr 1989). (CONF-881151–: 10. international conference on the application of accelerators in research and industry, Denton, TX (USA), 7-9 Nov 1988).

Valence electron density fluctuations induced around a trailing ion by a leading ion of a swift dicluster moving through condensed matter depend on the orientation of the dicluster axis with respect to the beam axis. These density fluctuations may appear experimentally in the angle dependence of the knock-on collision electrons emitted under bombardment of molecular ions. We present linear-response theory calculations of the density fluctuations at the position of the trailing ion, as a function of the orientation. Second-order perturbation theory calculations of the dependence on the angle of the scattering probabilities of target valence electrons by a two-center Coulomb field moving with different velocities are presented. The applicability of linear theories as the charges and velocities of diclusters are changed is discussed. (orig.).

48528 Intermediate-velocity molecular and atomic ions in solids. Steuer, M.F. (Georgia Univ., Athens (USA)); Ritchie, R.H. *Nuclear Instruments and Methods in Physics Research, Section B: Beam Interactions with Materials and Atoms (Netherlands)*, 40/41(pt.1): 372-375 (Apr 1989). (CONF-881151–: 10. international conference on the application of accelerators in research and industry, Denton, TX (USA), 7-9 Nov 1988).

Energy losses in solids by beam-aligned molecular ions have been shown to be diminished relative to those of atomic ions of the same velocity. Analyses utilizing Brandt-Kitagawa-model charge distributions, and either the dielectric function for a damped electron gas or an extended dielectric function determined from optical measurements, support a hypothesis that the charges of the atomic fragments are reduced when they move together at small values of internuclear separation; i.e., interference effects arising from their correlated motions are insufficient to explain experimental observations. Extending the Bohr-Lindhard model for electron capture by atomic ions one finds a predicted reduction in charge of closely spaced ion pairs which arises from an enhanced electron capture probability for each atomic ion when it moves in the field of its partner; the estimated effect is consistent with experiment. (orig.).

48529 Electronic stopping power of ions in solids. Ozturk, N. (Toledo Univ., OH (USA). Dept. of Physics and Astronomy); Williamson, W. Jr.; Antolak, A.J. *Physics Letters [Section] A (Netherlands)*, 138(9): 507-508 (17 Jul 1989).

A correction to a universal electronic stopping power for ions in solids is presented. For the stopping of some ion in solids the correction can be significant. (orig.).

6561 Superconductivity

Refer also to citation(s) 47404, 47732, 48526

48530 (IC–89/89) **Further studies on possible coexistence of antiferromagnetism and superconductivity in 2D Heisenberg model.** Chen Hao; Su Zhaobin; Yu Lu. International Centre for Theoretical Physics, Trieste (Italy). May 1989. 19p. Order Number DE90601082/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

The question of possible coexistence of antiferromagnetism (AF) and superconductivity (SC) is re-examined with the t - J model by using an improved mean field treatment. The renormalization of the effective Hamiltonian and the symmetry of the order parameters are properly taken into account. Our calculations reconfirm the possible coexistence of AF and SC below critical doping concentrations δ_c = 0.04 and 0.06 for t/J = 5 and 2.5, respectively, in good agreement with recent variational Monte Carlo results. This conclusion is consistent with the μSR data. Among pairings of various symmetries, the d-wave pairing has the lowest energy. (author). 21 refs, 7 figs.

48531 (LA-UR–89-2680) **A fermi liquid electric structure and the nature of the carriers in high-T_c cuprates: A photoemission study.** Arko, A.J.; List, R.S.; Bartlett, R.J.; Cheong, S.W.; Fisk, Z.; Thompson, J.D.; Olson, C.G.; Yang, A.B.; Liu, R.; Gu, C.; Veal, B.W.; Liu, J.Z.; Paulikas, A.P.; Vandervoort, K.; Claus, H.; Campuzano, J.C.; Schirber, J.E.; Shinn, N.D. Los Alamos National Lab., NM (USA). 1989. 32p. Sponsored by DOE/MA;NSF. DOE Contract W-7405-ENG-36;W-31109-ENG-38;W-7405-ENG-82. DMR8601349.

(CONF-8907130–2: 9. vacuum ultraviolet radiation conference, Honolulu, HI (USA), 17-21 Jul 1989). Order Number DE89016774/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

We have performed angle-integrated and angle-resolved photoemission measurements at 20 K on well-characterized single crystals of high-T_c cuprates (both 1:2:3-type and 2:2:1:2-type) cleaved in situ, and find a relatively large, resolution limited Fermi edge which shows large amplitude variations with photon energy, indicative of band structure final state effects. The lineshapes of the spectra of the 1:2:3 materials as a function of photon energy are well reproduced by band structure predictions, indicating a correct mix of 2p and 3d orbitals on the calculations, while the energy positions of the peaks agree with calculated bands only to within ≈0.5 eV. This may yet prove to reflect the effects of Coulomb correlation. We nevertheless conclude that a Fermi liquid approach to conductivity is appropriate. Angle-resolved data, while still incomplete, suggest agreement with the Fermi surface predicted by the LDA calculations. A BCS-like energy gap is observed in the 2:2:1:2 materials, whose magnitude is twice the weak coupling BCS value (i.e., $2\Delta = 7\ KT_c$). 49 refs., 11 figs.

48532 (LA-UR–89-2885) **Phonons and charge-transfer excitations in HTS superconductors.** Bishop, A.R. Los Alamos National Lab., NM (USA). 1989. 25p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-8907139–1: International School of Materials Science and Technology: earlier and recent aspects of superconductivity, Erice (Italy), 4-16 Jul 1989). Order Number DE89016616/JAW. Available from NTIS, PC A03; OSTI; INIS; GPO Dep.

Some of the experimental and theoretical evidence implicating phonons and charge-transfer excitations in HTS superconductors is reviewed. It is suggested that superconductivity may be driven by a synergistic interplay of (anharmonic) phonons and electronic degrees of freedom (e.g., charge fluctuations, excitons). 47 refs., 5 figs.

48533 (ORNL/FTR–3092) **[Neutron scattering experiments on high-temperature superconducting materials]: Foreign trip report, September 13, 1988–October 4, 1988.** Mook, H.A. Oak Ridge National Lab., TN (USA). 21 Oct 1988. 7p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017451/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The trip to the Institut Laue-Langevin (ILL) was made to perform neutron scattering experiments on the new high-temperature superconducting materials. Part of this work could have been accomplished at the High Flux Isotope Reactor (HFIR) at ORNL had it been operational; other parts utilized the special instrumentation at the ILL available at no other place. Experiments performed were the following: high-energy magnetic excitations in pure and Ba-doped La_2CuO_4, magnetic excitations and structural phase transitions in the $Bi_2Ba_2Cu_1O_6$ superconductor, search for the fluxoid lattice in the high-temperature materials, and magnetic spin structures in $ErBa_2Cu_3O_7$ and $GdBa_2Cu_3O_{6.5}$. Measurements were also made on supermirrors important for polarizing and neutron guide applications.

48534 (ORNL/FTR–3349) **[Origins of high-temperature superconductivity in the new copper oxide based ceramic superconductors]: Foreign trip report, July 20, 1988–July 29, 1989.** Wood, R.F. Oak Ridge National Lab., TN (USA). 14 Aug 1989. 24p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89016543/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler spent a year at the University of Erlangen-Nuernberg, Erlangen, FRG, funded by a Senior US Scientist Award from the Alexander von Humboldt Foundation. Brief background information on the von Humboldt Foundation and on the Friedrich-Alexander- Universitaet Erlangen-Nuernberg is given. The traveler's theoretical work on high-T_c superconductivity at Erlangen, carried out primarily at the Chair for Theoretical Chemistry, was concentrated on excitonic and spin-polaron mechanisms for superconductivity. Brief comments and observations related to interactions and travel during the year are given. Finally, some general observations about science and the university system in the Federal Republic of Germany are made.

48535 (UCRL–100695) **Superconductivity and magnetic scattering in the $Nd_{2-x}Ce_xCuO_{4-\delta}$.** Peng, J.L.; Shelton, R.N.; Radousky, H.B. Lawrence Livermore National Lab., CA (USA). Jul 1989. 3p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890718–26: International conference on materials and mechanisms of superconductivity - high-temperature superconductors, Stanford, CA (USA), 23-28 Jul 1989). Order Number DE89016524/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Samples of $Nd_{2-x}Ce_xCuO_{4-\delta}$ were prepared by annealing both in air and under vacuum. Electrical resistivity measurements showed that these materials in their normal state demonstrate a Kondo anomaly resulting from a combination of magnetic and phonon scatterings. 3 refs., 2 figs.

48536 Calculations of resistivity and superconducting T_c in transition metals. Allen, P.B. (Dept. of Physics, SUNY, Stony Brook, NY (US)); Beauiac, T.P.; Khan, F.S.; Butler, W.H.; Pinski, F.J.; Swihart, J.C. vp of Computer-based microscopic description of the structure and properties of materials. Broughton, J.; Krakow, W.; Pantelides, S.T. Materials Research Society, Pittsburgh, PA (1986). (CONF-851217–: Materials Research Society meeting, Boston, MA (USA), 2-7 Dec 1985).

A survey is given of various electron-phonon effects which have been calculated for the metals Nb, Mo, Ta, Pd, and Cu. These effects include the mass enhancement λ, superconducting T_c, electrical and thermal resistivity, Hall coefficient, magnetoresistance, and the successfully tested predictions of linewidths γQ of phonons. The calculations use local density approximations (LDA) energy bands, experimental phonons, and the rigid muffin tin (RMT) approximation. Mesh size noise is less than 1% and the Bloch-Boltzmann integral equation has been solved to unprecedented accuracy.

48537 Microstructural dynamic study of grain growth. Anderson, M.P. (Exxon Research and Engineering Co., Annandale, NJ (US)); Grest, G.S.; Srolovitz, D.J. vp of Computer-based microscopic description of the structure and properties of materials. Broughton, J.; Krakow, W.; Pantelides, S.T. Materials Research Society, Pittsburgh, PA (1986). (CONF-851217–: Materials Research Society meeting, Boston, MA (USA), 2-7 Dec 1985).

The complete prediction of microstructural development in polycrystalline solids as a function of time and temperature is a major objective in materials science, but has not yet been possible primarily due to the complexity of the grain interactions. The evolution of the polycrystalline structure depends upon the precise specification of the coordinates of the grain boundary network, the crystallographic orientations of the grains, and the postulated microscopic mechanisms by which elements of the boundaries are assumed to move. Therefore, a general analytical solution to this multivariate problem has not yet been developed. Grain growth is the term used to describe the increase in average grain size which occurs upon annealing a polycrystalline aggregate after primary primary recrystallization is complete.

6570 Theoretical and Mathematical Physics

Refer also to citation(s) 47416, 47823, 48383, 48403, 48420, 48423, 48425, 48663, 48723, 48736

48538 (AD-A–207442/5/XAB) **Maximum-likelihood identification of structurally constrained covariances for initial-condition statistics.** Smith, R.H. Johns Hopkins Univ., Laurel, MD (USA). Applied Physics Lab. 20 Jun 1986. 7p. Available from NTIS, PC A02/MF A01.

Pub. in Proceedings of the American Control Conference, 1242-1248(20 Jun 1988).

Maximum-likelihood estimation of a constrained initial condition covariance matrix is treated. The associated cross-sectional observations are generated from non-identically distributed realizations of a linear dynamic system. The covariance matrix is constrained to both band-block structure and to general positive semi-definiteness. Necessary and sufficient conditions are derived for the local optimality of the constrained covariance estimate, and an algorithm for the numerical solution of the related optimality equations is indicated. An implementation of the EM method, which is useful in

initializing the algorithm, is also presented for estimation in the band-block structurally constrained case.

48539 (CONF-8409210–, pp. 529-549) **Present status of the many-body problem.** Krotscheck, E. (Texas A and M Univ., College Station (USA)). Oak Ridge National Lab., TN (USA); Texas A and M Univ., College Station, TX (USA). Dept. of Chemistry. 1984. From Texas A and M symposium on theory, modeling and instrumentation for materials design; College Station, TX (USA); 17-19 Sep 1984. In *Theory, modeling and instrumentation for materials by design. Proceedings of workshop.* Order Number DE89007940/JAW. Available from NTIS, PC A99/MF A01.

The author reports here on some recent work that was carried out partly at A and M, which aims for a microscopic understanding of large, inhomogeneous quantum systems. The author believes that this subject is also one of the developments in modern many-body theory that is closest to the subject of the workshop. To some extent it is, of course, also necessary to review the results of other groups, mainly those who do Monte-Carlo simulations. He begins by briefly discussing the different approaches of an experimentalist and a theorist towards investigating a many-body system.

48540 (IC–89/56) **SL(2,R) current algebra in two dimensional conformal quantum gravity.** Abdalla, E.; Abdalla, M.C.B.; Zadra, A. International Centre for Theoretical Physics, Trieste (Italy). Apr 1989. 8p. Order Number DE90600755/JAW. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS.

The SL(2,R) current algebra in conformal two dimensional gravity is obtained directly from the residual symmetries of the theory in light-cone gauge. The relation of the theory with previous results is discussed. (author). 5 refs.

48541 (IC–89/57) **Mixed singular linear elliptic equations.** Duong Minh Duc; Luckhaus, S. International Centre for Theoretical Physics, Trieste (Italy). May 1989. 19p. Order Number DE90600722/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

We establish the existence and nontangent convergence properties of solutions of mixed singular elliptic equations. (author). 18 refs.

48542 (IC–89/58) **What can we do with only a pair of rusty compasses.** Zhang Jingzhong; Yang Lu; Hou Xiaoreng. International Centre for Theoretical Physics, Trieste (Italy). Apr 1989. 17p. Order Number DE90600723/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Compasses are called rusty, if one can draw only the unit circle with them. We prove that: From two points A and B, with only rusty compasses, one can draw the points of k-section of AB, and all the vertices of a regular n-gon which has a side AB, where k is any integer greater than 1, and n=3,4,5,6,8,12,17,257,..etc. Generally, let A be (0,0) and B be (λ,0), then one can draw all the points (λx,λy) where x and y are any elements in some regular 2^m-extension of the rational field, for m=1,2,3,... (author). 10 refs, 11 figs.

48543 (IC–89/61) **Theory of singular Lagrangians.** Carinena, J.F. International Centre for Theoretical Physics, Trieste (Italy). Apr 1989. 47p. Order Number DE90600735/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

The Lagrangian description of a system in Dirac's approach is analysed from a geometric viewpoint. The geometric tools used in such a description are those of (pre-) symplectic geometry. The theory of Hamiltonian dynamical systems is presented, showing how both the Hamiltonian and Lagrangian approaches arise as particular cases when the Lagrangian is regular and the case of presymplectic systems corresponding to the case of Lagrangian being singular is carefully analysed. 42 refs.

48544 (IC–89/66) **Nonlinear effects in water waves.** Janssen, P.A.E.M. International Centre for Theoretical Physics, Trieste (Italy). May 1989. 78p. Order Number DE90600724/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

This set of lecture notes on nonlinear effects in water waves was written on the occasion of the first ICTP course on Ocean Waves and Tides held from 26 September until 26 October 1988 in Trieste, Italy. It presents a summary and unification of my knowledge on nonlinear effects of gravity waves on an incompressible fluid without vorticity. The starting point of the theory is the Hamiltonian for water waves. The evolution equations of both weakly nonlinear, shallow water and deep water gravity waves are derived by suitable approximation of the energy of the waves, resulting in the Korteweg-de Vries equation and the Zakharov equation, respectively. Next, interesting properties of the KdV equation (solitons) and the Zakharov equation (instability of a finite amplitude wave train) are discussed in some detail. Finally, the evolution of a homogeneous, random wave field due to resonant four wave processes is considered and the importance of this process for ocean wave prediction is pointed out. 38 refs, 21 figs.

48545 (IC–89/70) **Generalization of the spaces l_p.** Lubuma, M.S. International Centre for Theoretical Physics, Trieste (Italy). May 1989. 14p. (In French). Order Number DE90600725/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

The classical spaces $l_p=l_p(N,R)$ are generalized into topological vector spaces $l_p(I,Y)$ by replacing N and R by a non empty set I and a topological vector space Y respectively. Various topological and order structures are considered by showing that $l_p(I,Y)$ satisfies a given property if Y does so. For normed spaces, a characterization of the reflexivity and of the dual of $l_p(I,Y)$ is given. (author). 10 refs.

48546 (IC–89/78) **Enveloping algebras for a large class of H-algebras.** Vuong Manh Son. International Centre for Theoretical Physics, Trieste (Italy). May 1989. 13p. Order Number DE90600726/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

We give a counterexample for the Rosenberg Conjecture and study the structure of enveloping algebras of a large class of Lie algebras of H-groups. 6 refs.

48547 (IC–89/85) **E=(h/2π)ω.** Barut, A.O. International Centre for Theoretical Physics, Trieste (Italy). May 1989. 8p. Order Number DE90600736/JAW. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS.

We construct localized oscillating finite energy solutions of the massless wave equation which move like massive relativistic particles with energy E = $\gamma\omega$ and momentum p-vector = γk-vector where ω is the frequency of the oscillating lump and k-vector its wave vector. It is a construction of a single massive "quantum particle" from "light". (author). 11 refs.

48548 (IC–89/86) **Approximation method for nonlinear integral equations of Hammerstein type.** Chidume, C.E.; Moore, C. International Centre for Theoretical Physics, Trieste (Italy). May 1989. 10p. Order Number DE90600727/JAW. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS.

The solution of a nonlinear integral equation of Hammerstein type in Hilbert spaces is approximated by means of a fixed point iteration method. Explicit error estimates are given and, in some cases, convergence is shown to be at least as fast as a geometric progression. (author). 25 refs.

48549 (IC–89/87) **Existence, uniqueness and approximation of a solution for a K-positive definite operator equation.** Chidume, C.E.; Aneke, S.J. International Centre for Theoretical Physics, Trieste (Italy). May 1989. 9p. Order Number DE90600728/JAW. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS.

The notion of a K-positive definite (K pd) operator which has been studied for Hilbert spaces is extended to real separable strictly convex Banach spaces, X. For such an X, it is proved that the equation Au = f, f ϵ X, where A is a K pd operator with the same domain as K, has a unique solution. Furthermore, a strongly convergent iteration process is constructed. (author). 14 refs.

48550 (IC–89/88) **Integrable classical systems in higher dimensions.** Mishra, S.C.; Parashar, D. International Centre for Theoretical Physics, Trieste (Italy). May 1989. 11p. Order Number DE90600737/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

A general method for the construction of the second constant of motion (up to second order) for higher dimensional classical systems is carried out. Correspondingly, the first and the second order potential equations are obtained whose solutions can directly provide the integrable systems. (author). 19 refs.

48551 (IC–89/93) **On some integral relations involving a generalized hypergeometric polynomial.** Khan, I.A.; Prasad, R. International Centre for Theoretical Physics, Trieste (Italy). May 1989. 7p. Order Number DE90600729/JAW. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS.

Some integral relations involving a generalized hypergeometric polynomial, have been further extended by employing Mellin's inversion formula. The results obtained here, yield very interesting particular cases. (author). 4 refs.

48552 (IC–89/99) **Are gravitons windows to higher dimensions.** Sokolowski, L.M. International Centre for Theoretical Physics, Trieste (Italy). May 1989. 11p. Order Number DE90600756/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

A plane-fronted gravitational wave with parallel rays (pp wave) interacting with the radius of the internal space (the dilaton field) is studied for any number of dimensions. In four dimensions the wave reduces to a Kerr-Schild wave coupled to the dilaton. It is distinguished from an ordinary system gravitational-wave-scalar-field by a special relation between one of its invariants and the source. (author). 14 refs.

48553 (IC–89/105) **Continuous spontaneous reduction model involving gravity.** Ghirardi, G.C.; Grassi, R.; Rimini, A. International Centre for Theoretical Physics, Trieste (Italy). Jun 1989. 29p. Order Number DE90600730/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

A continuous reduction model implying the dynamical suppression of linear superpositions of macroscopically distinguishable states, presented recently by L. Diosi, is investigated. The model exhibits appealing features, in particular it relates reduction to gravity and contains no constants besides Newton's gravitational constant G. It turns out, however, that the model is not fully consistent. A modification of it is proposed, which overcomes the difficulties and retains partially its nice features. The resulting model deals with systems containing distinguishable or identical constituents, allows the derivation from microdynamics of wave packet reduction and accounts for the emergency of definite macroscopic properties for macro-objects. Reduction is related to gravity in the same way as in Diosi's model, but a fundamental length must be introduced to avoid inconsistencies. (author). 12 refs.

48554 (IC–89/107) **Correlation radius for one-dimensional impenetrable bosons.** Its, A.R.; Izergin, A.G.; Korepin, V.E. International Centre for Theoretical Physics, Trieste (Italy). May 1989. 8p. Order Number DE90600731/JAW. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS.

Completely integrable partial differential equations for equal-time temperature correlators of impenetrable bosons are obtained. The explicit formulae valid for any density and temperature are given for the correlation radius. (author). 13 refs.

48555 (IC–89/116) **Survey on conformal flatness and quasiumbillicity of submanifolds.** Zafindratafa, G.K. International Centre for Theoretical Physics, Trieste (Italy). Jun 1989. 11p. Order Number DE90600716/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Presently, some confusions are made on the way of understanding the relation and the difference between the conformal flatness and the quasiumbilicity of submanifolds. The purpose of this paper is to make a clarification on these two topics: We review all the up-to-date known main results and the open related problems. (author). 18 refs.

48556 (IC–89/117) **Few remarks on anti-invariant quasiumbilical submanifolds.** Zafindratafa, G. International Centre for Theoretical Physics, Trieste (Italy). Jun 1989. 12p. Order Number DE90600717/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

The question which motivates this work is the following: "Determine all anti-invariant quasiumbilical submanifolds of codimension n in R^{2n}". K. Yano and M. Kon answered such a question in (KY) for the particular case when M is umbilical; they proved that an anti-invariant n-submanifold of R^{2n} is umbilical if and only if it is geodesic. We generalize such a result. Let M be quasiumbilical anti-invariant submanifold of codimension n in R^{2n}, p a point of M, and $\xi_1,...,\xi_n$ any system of n mutually orthonormal quasiumbilical vectors of $T_{\text{arrowup}}{}^1M$; then if there exists an index i, $1 \leq i \leq n$, such that ξ_i is umbilical, ξ_i is geodesic. Moreover, if M is complete and with parallel second fundamental form, if the dimension of the first principal normal space is constant and at the most equal to 2 at each point, M is a flat submanifold having either the form R^n, or the form $R^{n-1}xS^1$, or the form $S^1xS^1xR^{n-2}$, where dim (M) = n $\geq$3. (author). 3 refs.

48557 (IC–89/118) **On gauge fixing and quantization of constrained Hamiltonian systems.** Dayi, O.F. International Centre for Theoretical Physics, Trieste (Italy). Jun 1989. 11p. Order Number DE90600732/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

In constrained Hamiltonian systems which possess first class constraints some subsidiary conditions should be imposed for detecting physical observables. This issue and quantization of the system are clarified. It is argued that the reduced phase space and Dirac method of quantization, generally, differ only in the definition of the Hilbert space one should use. For the dynamical systems possessing second class constraints the definition of physical Hilbert space in the BFV-BRST operator quantization method is different from the usual definition. (author). 18 refs.

48558 (IC–89/119) **Multigrid techniques with non-standard coarsening and group relaxation methods.** Danaee, A. International Centre for Theoretical Physics, Trieste (Italy). Jun 1989. 11p. Order Number DE90600718/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

In the usual (standard) multigrid methods, doubling of grid sizes with different smoothing iterations (pointwise, or blockwise) has been considered by different authors. Some have indicated that a large coarsening can also be used, but is not beneficial (cf. H3, p.59). In this paper, it is shown that with a suitable blockwise smoothing scheme, some advantages could be achieved even with a factor of $H_{l-1}/h_l = 3$. (author). 10 refs, 2 figs, 6 tabs.

48559 (IC–89/120) **Temperature correlators of the impenetrable Bose gas as an integrable system.** Its, A.R.; Izergin, A.G.; Korepin, V.E. International Centre for Theoretical Physics, Trieste (Italy). Jun 1989. 24p. Order Number DE90600733/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

It is shown that the temperature equal-time correlators of impenetrable bosons in one space dimension are described by a classical integrable system. Partial differential equations for two-point as well as for multipoint correlators are obtained. The short-distance and low-density expansions are constructed. (author). 12 refs.

48560 (IC–89/125) **Excited states of zitterbewegung.** Barut, A.O. International Centre for Theoretical Physics, Trieste (Italy). May 1989. 7p. Order Number DE90600734/JAW. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS.

The quantization of the classical spinning particle with zitterbewegung leads besides the Dirac electron to a family of generalized Duffin-Kemmer-Petiau particles which are thus all different possible quantum states of the same classical system. (author). 14 refs.

48561 (IC–89/134) **Space of harmonic maps of S^2 into S^4.** Loo, B. International Centre for Theoretical Physics, Trieste (Italy). May 1989. 25p. Order Number DE90600719/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Every branched superminimal surface of area $4\pi d$ in S^4 is shown to arise from a pair of meromorphic functions (f_1,f_2) of bidegree (d,d) such that f_1 and f_2 have the same ramification divisor. Conditions under which branched superminimal surfaces can be generated from such pairs of functions are derived. For each $d \geq 1$ the space of harmonic maps (i.e branched superminimal immersions) of S^2 into S^4 of harmonic degree d is shown to be a connected space of complex dimension 2d+4. (author). 18 refs.

48562 (IC–89/142) **Multiplet classification of highest weight modules over quantum universal enveloping algebras: The $U_q(sl(3,C))$ example.** Dobrev, V.K. International Centre for Theoretical Physics, Trieste (Italy). May 1989. 15p. Order Number DE90600720/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

The multiplet classification approach is extended to the quantum universal enveloping algebras $U_q(G)$, where G is any simple Lie algebra. In the case when the deformation parameter q is a root of unity we classify into multiplets and explicitly parametrize all highest weight modules (HWM) over $U_q(sl(2,C))$ and $U_q(sl(3,C))$. As a consequence we classify all irreducible HWM over $U_q(sl(3,C))$ and give the dimensions of some of them. The same is done for $U_q(sl(2,C))$ reproducing the results obtained earlier by other methods. (author). 28 refs.

48563 (IC–89/153) **On quantum effects near a black hole singularity.** Qadir, A.; Siddiqui, A.A. International Centre for Theoretical Physics, Trieste (Italy). Jun 1989. 5p. Order Number DE90600754/JAW. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS.

It is pointed out that the claim made by Joshi and Joshi, has not been rigorously demonstrated by them. A simpler and more correct proof is provided. (author). 4 refs.

48564 (INIS-mf–11514, pp. 633-641) **16/16, N=1 supergravity: the low energy limit of the superstring.** Ovrut, B.A. (Pennsylvania Univ., Philadelphia, PA (USA). Dept. of Physics). Warsaw Univ. (Poland). Inst. Fizyki Doswiadczalnej; Warsaw Univ. (Poland). Inst. Fizyki Teoretycznej. 1985. (CONF-8505238–: 8. Warsaw symposium on elementary particle physics, Kazimierz (Poland), 26 May - 1 jun 1985). In *Proceedings of the 8 Warsaw symposium on elementary particle physics, Kazimierz, Poland, May 26 - June 1, 1985.* Order Number DE89635911/JAW. Available from NTIS (US Sales Only), PC A99/MF A01 - OSTI; INIS.

We analyze irreducible, N=1 supergravity theories with 16 bosonic and 16 fermionic degrees of freedom. The Lagrangians for pure 16/16 supergravity and for 16/16 supergravity coupled to arbitrary chiral superfields are constructed. These theories are shown to have natural SU(1,1) non-compact symmetry. The low energy field theory limit of the superstring is conjectured to be of this type. 6 refs., 2 tabs. (author).

48565 (INIS-mf–11515, pp. 77) **Relativistic corrections for the scattering matrix.** Bulla, W. (Technische Univ., Graz (Austria). Inst. fuer Theoretische Physik und Reaktorphysik); Unterkofler, K.; Gesztesy, F. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

'Short Communications.'

48566 (INIS-mf–11515, pp. 78) **Measurement of Berry's topological phase for non-cyclic evolution.** Badurek, G. (Techn. Univ. Vienna, Inst. fuer Kernphysik, Vienna (Austria)); Weinfurter, H. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48567 (INIS-mf–11515, pp. 82) **Neutron phase shift near a dynamic Bragg reflection.** Petraschek, D. (Johannes Kepler Univ., Inst. fuer Theoretische Physik, Linz (Austria)); Rauch, H.; Schmiedmayer, J. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48568 (INIS-mf–11515, pp. 127) **Novel methods for treating the inverse scattering problem.** Schnizer, W.A. (Techn. Univ. Vienna, Inst. fuer Kernphysik, Vienna (Austria)); Leeb, H. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48569 (INIS-mf–11515, pp. 124) **Restrictions on particle masses in supersymmetry.** Majerotto, W. (Oesterreichische Akademie der Wissenschaften, Vienna (Austria). Inst. fuer Hochenergiephysik); Moesslacher, B. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48570 (INIS-SU–113/A, pp. 7-9) **Strong quantum-mechanical instability of orbital motion of a macroscopic body in a gravitational field.** Bykov, V.P. (AN SSSR, Moscow (USSR). Inst. Obshchej Fiziki). AN SSSR, Moscow (USSR). Fizicheskij Inst. 1989. (In Russian). (T–23539). In *Experimental and theoretical physics. Collection.* Order Number DE89018003/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Kratkie soobshcheniya po fizike.; v. 1.

In the approximation of infinitesimal wave packet the quantum-mechanical equation, describing the motion of a macroscopic body over the orbit in a gravitational field, admits a stationary solution. The wave packet dimensions corresponding to the solution are calculated and its strong instability is shown. 4 refs.

48571 (KEK–88-12, pp. 94-109) **Quantum gravity and cosmological constant.** Hosoya, Akio (Hiroshima Univ., Takehara (Japan). Research Inst. for Theoretical Physics). National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). Jan 1989. (CONF-8808268–: Summer workshop on superstring theory, Tsukuba (Japan), 29 Aug - 3 sep 1988). In *Proceedings of the summer workshop on superstrings.* Order Number DE90001080/JAW. Available from NTIS (US Sales Only), PC A15/MF A01.

Recent development of wormhole instanton physics is reviewed with an emphasis on its analogy to string theories. (author).

48572 (LNCC–028/88) **Hidden regularity for a strongly nonlinear wave equation.** Rivera, J.E.M. Laboratorio Nacional de Computacao Cientifica, Rio de Janeiro, RJ (Brazil). Aug 1988. 22p. Order Number DE90600742/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

The nonlinear wave equation $u''-\Delta u+f(u)=v$ in $Q=\Omega x0,T;u(0)=u_0,u'(0)=u_1$ in Ω; $u(x,t)=0$ on $\Sigma=\Gamma x0,T$ where f is a continuous function satisfying, $\lim_{|s|}\sup_{->+\infty} f(s)/s>-\infty$, and Ω is a bounded domain of R^n with smooth boundary Γ, is analysed. It is shown that there exist a solution for the presented nonlinear wave equation that satisfies the regularity condition: —{ partial_deriv} u/{ partial_deriv} eta—ϵ $L^2(\Sigma)$. Moreover, it is shown that there exist a constant C>0 such that, —{ partial_deriv} u/{ partial_deriv} eta—$\leq$c{ E(0)+—v— ^2_Q} . (author).

48573 (N–89-20635) **Domain decomposition methods for systems of conservation laws: Spectral collocation approximations. Final report.** Quarteroni, A. National Aeronautics and Space Administration, Hampton, VA (USA). Inst. for Computer Applications in Science and Engineering. Jan 1989. 37p. (NASA-CR–181773;ICASE–89-5;NAS–1.26:181773). Available from NTIS, PC A03/MF A01.

Hyperbolic systems of conversation laws are considered which are discretized in space by spectral collocation methods and advanced in time by finite difference schemes. At any time-level a domain deposition method based on an iteration by subdomain procedure was introduced yielding at each step a sequence of independent subproblems (one for each subdomain) that can be solved simultaneously. The method is set for a general nonlinear problem in several space variables. The convergence analysis, however, is carried out only for a linear one-dimensional system with continuous solutions. A precise form of the error reduction factor at each iteration is derived. Although the method is applied here to the case of spectral collocation approximation only, the idea is fairly general and can be used in a different context as well. For instance, its application to space discretization by finite differences is straight forward.

48574 (N–89-20636) **Numerical studies of identification in nonlinear distributed parameter systems. Final report.** Banks, H.T.; Lo, C.K.; Reich, S.; Rosen, I.G. National Aeronautics and

Space Administration, Hampton, VA (USA). Inst. for Computer Applications in Science and Engineering. Jan 1989. 21p. (NASA-CR–181771;ICASE–89-3;NAS–1.26:181771). Available from NTIS, PC A03/MF A01.

An abstract approximation framework and convergence theory for the identification of first and second order nonlinear distributed parameter systems developed previously by the authors and reported on in detail elsewhere are summarized and discussed. The theory is based upon results for systems whose dynamics can be described by monotone operators in Hilbert space and an abstract approximation theorem for the resulting nonlinear evolution system. The application of the theory together with numerical evidence demonstrating the feasibility of the general approach are discussed in the context of the identification of a first order quasi-linear parabolic model for one dimensional heat conduction/mass transport and the identification of a nonlinear dissipation mechanism (i.e., damping) in a second order one dimensional wave equation. Computational and implementational considerations, in particular, with regard to supercomputing, are addressed.

48575 (N–89-20710) **Equivalence of Gaussian elimination and Gauss-Jordan reduction in solving linear equations.** Tsao, NAI-KUAN. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Feb 1989. 22p. (NASA-TM–101466;ICOMP–89-2;E–4577;NAS–1.15:101466). Available from NTIS, PC A03/MF A01.

A novel general approach to round-off error analysis using the error complexity concepts is described. This is applied to the analysis of the Gaussian Elimination and Gauss-Jordan scheme for solving linear equations. The results show that the two algorithms are equivalent in terms of our error complexity measures. Thus the inherently parallel Gauss-Jordan scheme can be implemented with confidence if parallel computers are available.

48576 (RRK–89-11) **(2+1)-dimensional pure gravity for an arbitrary closed initial surface.** Hosoya, Akio; Nakao, Ken-ichi. Hiroshima Univ., Takehara (Japan). Research Inst. for Theoretical Physics. Apr 1989. 25p. Order Number DE90701754/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

The (2+1)-dimensional pure Einstein gravity is studied in the ADM formalism. We completely solve the initial value and the time evolution problems with a closed Riemann surface being an initial surface, choosing the time slicing so that the trace of the extrinsic curvature is independent of spatial coordinates. The possible topology of the two-surface is either a torus or a Riemann surface of genus $g \geq 2$. It is shown that the moduli parameters of the torus follow the geodesic curve in the moduli space, while the motion of the moduli is static for the case $g \geq 2$. (author).

48577 (UCID–21767) **Auxiliary-field transformations for repulsive potentials: A physical approach.** Theilhaber, K. Lawrence Livermore National Lab., CA (USA). Aug 1989. 15p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE89016677/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

In this paper, we show that the imaginary coupling coefficient which arises in auxiliary field transformations on systems with repulsive Coulomb potentials is automatically obtained in the non-relativistic, electrostatic limit of the coupled electron-electromagnetic-field system. This suggests that the imaginary coupling term is not just a mathematical artifice, but that its appearance is deeply linked to the imaginary-time representation used for constructing the partition function of the electron-electromagnetic-field system. 7 refs.

48578 (UCRL–101396) **Resistive block methods for electrostatic field solutions with internal elements.** Nielsen, D.E. Jr.; Ambrosiano, J.J. Lawrence Livermore National Lab., CA (USA). Jul 1989. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890931–6: 13. conference on the numerical simulation of plasmas, Santa Fe, NM (USA), 17-20 Sep 1989). Order Number DE89017535/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The presence of conducting elements (e.g., electrodes) often makes numerical computations of electromagnetic fields within a bounded region awkward. At the interface or boundary between the conducting elements and the vacuum region, appropriate conditions must be prescribed and enforced. Such problems may be more conveniently posed if the elements are simply represented as blocks of material with specific values of resistance, dielectric constant and permitivity. The field solution can then be obtained over the whole region including the conducting elements without the need to specify fields at the interface. We refer to a field solution algorithm that incorporates regions having finite conductivity as a resistive block algorithm. An electromagnetic resistive block algorithm was introduced by Eppley and Drobot which is accurate and robust to timesteps that are large with respect to the resistive decay timescale $\tau_R = \epsilon/\sigma$ (σ is the conductivity and ϵ is the dielectric constant). This makes it applicable to problems having regions with metallic conductivities while allowing the solution to be advanced on a timescale appropriate to phenomena of interest, e.g., plasma physics. In this paper we reiterate the electromagnetic algorithm and show how to use the same approach to solve electrostatic problems. 2 refs., 1 fig.

48579 **Microcanonical Monte Carlo.** Creutz, M. (Brookhaven National Lab., Upton, NY (US)). vp of Simulation at the frontiers of science. Young, J.; Ingalls, V.W.; Hawkins, R Society for Computer Simulation, San Diego, CA (1986). (CONF-860359–: Eastern simulation conference, Norfolk, VA (USA), 10-12 Mar 1986).

The author discusses a recently developed algorithm for simulating statistical systems. The procedure interpolates between molecular dynamics methods and canonical Monte Carlo. The primary advantages are extremely fast simulations of discrete systems such as the Ising model and a relative insensitivity to random number quality. A variation of the algorithm gives rise to a deterministic dynamics for Ising spins. This model may be useful for high speed simulation of non-equilibrium phenomena.

48580 **Charge quantization of wormholes and the finiteness of Newton's constant.** Grinstein, B. (Fermi National Accelerator Lab., Batavia, IL (USA)). *Nuclear Physics [Section] B (Netherlands)*, 321(2): 439-464 (24 Jul 1989).

We derive, from first principles, the equations of Lee which exhibit wormhole solutions. The interpretation of such solutions becomes more transparent: they are local extrema of the action which contribute to transition amplitudes between states of definite charge. Hence the charge carried by the wormhole is quantized. We briefly review Coleman's mechanism for the vanishing of the cosmological constant, with emphasis on the problem of the vanishing of Newton's constant G. A mechanism is proposed that could naturally make 1/G a bounded function of the wormhole parameters. (orig.).

70 FUSION ENERGY

48581 (INIS-mf–11537) **17th AINSE plasma physics conference: conference handbook.** Australian Inst. of Nuclear Science and Engineering, Lucas Heights (Australia). 1989. 90p. (CONF-8902130–: 17. AINSE plasma physics conference, Lucas Heights (Australia), 6-8 Feb 1989). Order Number DE90600936/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

The conference sessions covered stellators, alfven waves, rotamak research, plasmas, RF current drives, laser fusion, high power ion cyclotron resonance, RF plasmas and magnetic confinement.

48582 (LA–11686-C) **Highlights of papers presented at the workshop on cold fusion phenomena.** Los Alamos National Lab., NM (USA). Sep 1989. 26p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-8905126–Summs.: Workshop on cold fusion phenomena, Santa Fe, NM (USA), 23-25 May 1989). Order Number DE89016956/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This report contains highlights of formal oral papers presented at the Workshop on Cold Fusion Phenomena, hosted by Los Alamos National Laboratory and held May 23–25, 1989, in Santa Fe, New Mexico. General topics covered are: physics of fusion reactions; neutron and gamma-ray spectroscopy; colorimetry; and applicable condensed-matter physics, electrochemistry, and analytical chemistry.

7001 Plasma Research

Refer also to citation(s) 48228, 48515, 48578, 48668, 48693, 48726

48583 (AD-A–207310/4/XAB) **Collisionless tearing instability of a bi-Maxwellian neutral sheet with exact particle orbits. Interim report.** Burkhart, G.R.; Chen, J. Naval Research Lab., Washington, DC (USA). 27 Mar 1989. 56p. (NRL-MR–6405). Available from NTIS, PC A04/MF A01.

The tearing instability of a neutral sheet may be important to reconnection in the magnetosphere and elsewhere. The use of a bi-Maxwellian Harris equilibrium is broadly applicable to the physical environment and allows a continuous variation from isotropic situations. The integro-differential equation describing the linear tearing instability in the bi-Maxwellian neutral sheet is solved without approximating the particle orbits. Results of this calculation are presented. Comparison between the exact solution and the 3-region approximation motivates the piecewise-straight-line approximation, a simplification which allows faster solution of the integro-differential equation, yet retains the important features of the exact solution.

48584 (ANU/TPP–88/01) **Symmetry breaking bifurcations of a current sheet.** Parker, R.D.; Dewar, R.L.; Johnson, J.L. Australian National Univ., Canberra (Australia). Research School of Physical Sciences. Aug 1988. 24p. Order Number DE90601005/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Submitted to Phys. Fluids.

Using a time evolution code with periodic boundary conditions, the viscoresistive hydromagnetic equations describing an initially static, planar current sheet with large Lundquist number have been evolved for times long enough to reach a steady state. A $\cosh^2 x$ resistivity model was used. For long periodicity lengths, L_p, the resistivity gradient drives flows which cause forced reconnection at X point current sheets. Using L_p as a bifurcation parameter, two new symmetry breaking bifurcations were found - a transition to an asymmetric island chain with nonzero, positive or negative phase velocity, and a transition to a static state with alternating large and small islands. These states are reached after a complex transient behavior which involves a competition between secondary current sheet instability and coalescence. 31 refs., 6 figs.

48585 (DOE/ER/53218–11) **Fusion plasma theory: Task 3, Auxiliary heating in tokamaks: Progress report, [1988–1989].** Scharer, J.E. Wisconsin Univ., Madison, WI (USA). Dept. of Electrical and Computer Engineering. Jul 1989. 8p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-86ER53218. Order Number DE89017401/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The research that we have accomplished during the past year (1988–1989) includes the topics of ICRF fast wave waveguide coupling to H-mode profiles simulating CIT and full wave ICRF field solutions and a power conservation relation based on fundamental principles with JET and CIT heating applications. We have also published work on Fokker-Planck simulations of minority ion ICRF strong core electron sawteeth processes in JET, a publication on the effect of plasma edge density fluctuation and ponderomotive force effects on the coupling of ion Bernstein waves and a publication on the coupling of dielectric filled waveguides to plasmas in the ICRF. The analysis of ICRF H-mode coupling is crucial to the economic success of proposed ignition devices such as CIT and ITER. We have analyzed the coupling of ICRF waveguide launchers to H-mode density profiles modelled by a pedestal width and Gaussian edge variations with gradients comparable to current machines. We find that the launcher aperture spectrum, density gradients and width of the pedestal are important parameters in determining the coupling efficiency. The launcher-plasma admittance spectrum in k_y-k_z space is utilized to show that the H-mode launcher reflections increase when compared to the L-mode profile, but that they can be handled by launcher matching circuits and modest modifications of the H-mode profile. We plan to analyze the recent successful JET ICRF H-mode operation utilizing our formalism. We have also carried out a full wave ICRF field solution and the associated power conservation relation with expressions evaluated up to the third harmonic. We have implemented this in a computer code which utilizes invariant imbedding to solve the system of equations. 7 refs., 1 tab.

48586 (IC–89/135) **Ion-sound emission by Langmuir soliton crossing density barrier.** El-Ashry, M.Y.; Tskhakaya, D.D. International Centre for Theoretical Physics, Trieste (Italy). Jun 1989. 13p. Order Number DE90601020/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

The one-dimensional motion of a Langmuir soliton passing through the region of a density barrier is considered. It is found that the soliton is accelerated due to the plasma inhomogeneity. The accelerated soliton radiates two pulses of ion-sound waves propagated in opposite directions away from the barrier. The spatial distribution of the perturbed density in the ion-sound waves is investigated and the energy loss of the soliton, as a result of the emission, is estimated. (author). 5 refs, 4 figs.

48587 (IC–89/138) **Possibility of low-frequency electron wave in a beam-plasma system.** El-Ashry, M.Y.; Talukdar, I. International Centre for Theoretical Physics, Trieste (Italy). Jun 1989. 8p. Order Number DE90601021/JAW. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS.

In the present work the attention has been drawn to the possibility of existence and excitation of an electron low-frequency wave by electron beam in electron plasma. The instability analysis has been done to show that a new spectrum of low frequency electromagnetic waves are excited by the beam. The growth rate of excitation is also found out. (author). 9 refs.

48588 (IC–89/146) **On averaged force acting on a particle in H.F electromagnetic field.** Ogunniyi, J.F.; Tskhakaya, D.D. International Centre for Theoretical Physics, Trieste (Italy). Jun 1989. 8p. Order Number DE90600984/JAW. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS.

A general expression is obtained for the time averaged force acting on a particle immersed in a magnetic field in the presence of H.F quasiplanar, quasimonochromatic electromagnetic wave. Here, averaging is done over the period of the H.F wave. It is shown that this averaged force is proportional to the time derivative of the squared H.F wave amplitude. The force also includes a term proportional to the gradient of the time constant magnetic field and is connected with the induced magnetic moment in the H.F field. (author). 7 refs.

48589 (INIS-mf–11515, pp. 81) **Toroidal parallel flow in Tokamaks.** Cap, F. (Innsbruck Univ. (Austria). Inst. fuer Theoretische Physik). Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

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48641 (INIS-mf–11537, pp. 62) **Effect of small-scale inhomogeneities on the properties of waves in plasmas.** Melrose, D.B. (Sydney Univ. (Australia). School of Physics). Australian Inst. of Nuclear Science and Engineering, Lucas Heights (Australia). 1989. (CONF-8902130–: 17. AINSE plasma physics conference, Lucas Heights (Australia), 6-8 Feb 1989). In *17th AINSE plasma physics conference: conference handbook.* Order Number DE90600936/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.
Abstract only.

48642 (INIS-mf–11537, pp. 63) **Observation of m = +- 1 MHD surface waves and shear Alfven waves converted from surface waves.** Amagishi, Y. (Shizuoka Univ. (Japan)). Australian Inst. of Nuclear Science and Engineering, Lucas Heights (Australia). 1989. (CONF-8902130–: 17. AINSE plasma physics conference, Lucas Heights (Australia), 6-8 Feb 1989). In *17th AINSE plasma physics conference: conference handbook.* Order Number DE90600936/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.
Abstract only.

48643 (INIS-mf–11537, pp. 72) **Nonlinear hybrid TE-TM waves in a flowing plasma.** Vukovic, S. (Australian National Univ., Canberra (Australia). Laser Physics Centre). Australian Inst. of Nuclear Science and Engineering, Lucas Heights (Australia). 1989. (CONF-8902130–: 17. AINSE plasma physics conference, Lucas Heights (Australia), 6-8 Feb 1989). In *17th AINSE plasma physics conference: conference handbook.* Order Number DE90600936/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.
Abstract only.

48644 (IPP–2/297) **On bootstrap currents in toroidal systems.** Wobig, H. Max-Planck-Institut fuer Plasmaphysik, Garching (Germany, F.R.). Oct 1988. 55p. Order Number DE90702887/JAW. Available from NTIS (US Sales Only), PC A04/MF A01.

In the present paper the diffusion driven current in tokamaks and stellarators is investigated. In stellarators neoclassical bootstrap currents are serious obstacles for achieving optimum confinement since the profile of the rotational transform is modified during the rise phase of the discharge. Following the theory of axisymmetric configurations like tokamaks, predictions for nearly axisymmetric stellarators like Wendelstein VII-A yield a bootstrap current of several kilo-Amps. In Wendelstein VII-AS application of the same equations yields currents up to 70 kA, depending on the achievable β. However, this estimate does not take into account the three-dimensional geometry of the magnetic surfaces and the optimization of drift orbits in Wendelstein VII-AS. In general stellarator geometry the magnitude of the bootstrap current depends on the localization of trapped particles and the kinetic equation has to be solved in order to compute the parallel viscosity which drives the bootstrap current. It can be shown that in configurations with symmetry - axisymmetry, helical symmetry, quasi-helical symmetry - bootstrap current and radial particle loss are proportional to each other. This relation follows directly from the momentum balance and the plasma viscosity given in Chew-Goldberger- Low formulation. This general relation, which is already known for tokamaks can be derived without solving the kinetic equation. Depending on the sign of $t - \gamma_\omega$, the bootstrap current in helical invariant stellarators can have the opposite sign compared with tokamaks (t is the rotational transform and γ_ω is the slope of the helical invariant lines B = const.). If the symmetry of the configuration is destroyed, it is possible to minimize the bootstrap current by a suitable choice of the magnetic field geometry. (orig./AH).

48645 (IPPCZ–281) **On lower hybrid wave scatteing by plasma density fluctuation. Nonlinear reflection coefficient of the fast magnetoacoustic wave.** Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1988. 15p. Order Number DE89018005/JAW. Available from NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS.

Selected papers have been processed separately for inclusion in the data base. (DLC)

48646 (IPPCZ–281, pp. 1-6) **On lower hybrid wave scattering by plasma density fluctuations.** Petrzilka, V. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1988. In *On lower hybrid wave scattering by plasma density fluctuation. Nonlinear reflection coefficient of the fast magnetoacoustic wave.* Order Number DE89018005/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

The scattering of lower hybrid waves on plasma density fluctuations in a thin turbulent layer at the plasma periphery is studied numerically. The lower hybrid waves are supposed to be radiated

by a four-waveguide grill used on the CASTOR tokamak. A great number of calculated scattered wave spectra show that the scattered spectrum shifts to larger values of the parallel-to-magnetic-field component of the wave vector (to slower waves) with increasing central plasma density and with the decreasing safety factor at the boundary. As known, this shift of the wave spectra results in a decrease in current drive efficiency. The current drive efficiency will hence decrease with growing plasma density and with decreasing safety factor. (J.U.). 2 figs., 4 refs.

48647 (IPPCZ–281, pp. 7-13) **Nonlinear reflection coefficient of the fast magnetoacoustic wave.** Petrzilka, V. Ceskoslovenska Akademie Ved, Prague (Czechoslovakia). Ustav Fyziky Plazmatu. May 1988. In *On lower hybrid wave scattering by plasma density fluctuation. Nonlinear reflection coefficient of the fast magnetoacoustic wave.* Order Number DE89018005/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

Nonlinear density perturbations due to ponderomotive forces may change the propagation and coupling of a fast magnetoacoustic wave at a frequency below the lower hybrid one. The propagation of fast magnetoacoustic waves is studied numerically on a simplified model of the grill and using the parameters of the PLT experiment. Specifically for the lower frequencies, nonlinear changes in the reflection coefficient are found to be quite substantial. Probably the most important effect discovered is the enhancement of the reflection coefficient for faster waves, which might have negative implications for various fast-wave current drive schemes. (J.U.). 5 figs., 2 refs.

48648 (IPPJ–896) **Z_{eff} measurements and low-Z impurity transport for NBI and ICRF heated plasma in JIPP T-IIU tokamak.** Ida, K.; Amano, T.; Kawahata, K.; Kaneko, O. Nagoya Univ. (Japan). Inst. of Plasma Physics. Dec 1988. 28p. Order Number DE90701583/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

A visible bremsstrahlung detector array system for Z_{eff} measurements and a charge exchange recombination spectroscopy (CXRS) system for fully ionized impurity profile measurements were installed on JIPP TII-U to study impurity transport for NBI and ICRF heated plasma. More impurities are sputtered by ICRF heating than by NBI and/or ohmic heatings. The carbon contribution to Z_{eff} is 80-90 % for NBI heated plasmas, and 60 % for NBI + ICRF heated plasmas. With a carbon coating of vacuum vessel, the Z_{eff} value decreases 2.4 to 1.7 and the carbon contribution to Z_{eff} increases up to 80-90 %. We obtain the diffusion coefficient D_a = 1.0 m^2/s and the convective velocity $V_a(a)$ = 13 m/s at the plasma edge for carbon impurity from the radial profile and time evolution of fully ionized carbon after the ICRF pulse is turned on. (author).

48649 (IPPJ–897) **Resistivity of flame plasma in an electric field.** Ikuta, Kazunari. Nagoya Univ. (Japan). Inst. of Plasma Physics. Jan 1989. 11p. Order Number DE90701584/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

A generalized Ohm's law is obtained for a flame plasma in an electric field for the study of arc resistivity in an electromagnetic launcher (EML). The effective resistivity of flame plasma is reduced by the source, which suggests the injection of premixed combustible fuel into the arc plasma in EML in order to reduce the electron energy of the arc. The reduction of electron energy in the arc is desirable to minimize the damage of electrodes in EML. (author).

48650 (IPPJ–898) **Limiter H-modes in the JIPP T-IIU tokamak.** Toi, K.; Adati, K.; Akiyama, R. and others. Nagoya Univ. (Japan). Inst. of Plasma Physics. Jan 1989. 13p. Order Number DE90701585/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

The H-mode is observed in a circular cross-section plasma bounded by a limiter on the JIPP T-IIU tokamak. This H-mode is achieved in the smallest tokamak and also in the highest density regime up to 10^{14} cm^3. The rapid current ramp-down during the additional heating considerably reduces the threshold power to the transition. (author).

48651 (IPPJ–904) **3-D resistive MHD simulation analysis of field reversal control in the reversed field pinch.** Nagata, A.; Ashida, H.; Koide, S.; Sato, K.I.; Amano, T. Nagoya Univ. (Japan). Inst. of Plasma Physics. Mar 1989. 38p. Order Number DE90701755/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

A three-dimensional resistive MHD simulation code under the compressibility condition is applied to analysis of the field reversal control in the reversed field pinch (RFP). Simulation results have shown that a loss of the field reversal at the wall leads to increase of q-value on the axis and broad one of the q-profile, and also the rapid increase of the fluctuating magnetic energy due to nonlinear tearing modes with the m=1 and m=2 modes. By deepening the field reversal at the wall, the reversal surface moves inside the plasma, and the q-profile becomes narrow. As a result, a rapid growth and saturation of these tearing modes is suppressed by the field reversal control. (author).

48652 (JAERI-M–89-021) **3-dimensional non-linear resistive MHD code using semi-implicit method.** Yamaguchi, Yuji; Kurita, Gen-ichi; Takeda, Tatsuoki. Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1989. 19p. (In Japanese). Order Number DE90701784/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

The 3-dimensional non-linear resistive MHD code based on full set of resistive MHD equations is developed. The code solves full set of resistive MHD equations without reducing directly by means of semi-implicit method in cylindrical geometry. Effective MHD computation can be performed and macroscopic phenomena in tokamak plasma that cannot be expressed by reduced set of MHD equations can be seen. Non-linear calculations of m=2/n=1 m=1/n=1 resistive modes are carried out and reasonable results are obtained. (author).

48653 (JAERI-M–89-036) **Experimental observation of ion Bernstein wave heating on JFT-2M tokamak.** Tamai, Hiroshi; Ogawa, Toshihide; Matsumoto, Hiroshi; Odajima, Kazuo. Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1989. 34p. Order Number DE90701782/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

Plasma heating by Ion Bernstein Wave (IBW) on JFT-2M tokamak is reported. IBW is a kind of slow wave, therefore dominant coupling with plasma ions and efficient heating are expected. Since IBW launcher is located at low field side of torus, it is advantageous as a method to heat the future reactor plasma. Our experiment is made at the generator frequency of $\omega=3/2\omega_H$ or $3\omega_D$, where ω_H, and ω_D are the ion cyclotron frequency of hydrogen and deuterium, respectively. Plasma loading impedance increases as outermost plasma surface approaches to the IBW launcher, and in approaching case the impedance decreases as averaged electron density increases. Increase of stored energy is observed by IBW heating. This is mainly contributed to density build-up, but a small part comes from net plasma heating. On the other hand, enhanced impurity radiation is observed during IBW heating, and the increment of radiation loss exceeds IBW launched power by a factor of two or three. In order to reduce the radiation enhancement, optimum condition is searched by surveying several plasma parameters like as configuration, current, density, and concentration ratio of hydrogen in deuterium. However, maximum IBW launched power is only 150 kW. Maximum launched power is increased up to 300 kW through the combination with neutral beam heating which compensates the radiation cooling. As same as IBW only case, the radiation increment limits the maximum value of launched power. Enhancement of high energy hydrogen up to 10 keV is observed. Loading impedance with H-mode plasma falls to about 40 % that with L-mode plasma, mainly due to the drastic change of edge plasma feature. H-mode plasma is terminated by only 20 kW of IBW power, because of edge plasma heating. (author).

48654 (JAERI-M–89-050) **Confinement properties of pellet injected JT-60 plasmas.** Kamada, Yutaka; Yoshino, Ryuji; Nagami, Masayuki and others. Japan Atomic Energy Research Inst., Tokyo (Japan). May 1989. 36p. Order Number DE90701750/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

Improved energy confinement for additionally heated JT-60 limiter and lower x-point discharges have been obtained with hydrogen pellet injection. Energy confinement time was enhanced up to 40 % relative to usual gas fuelled discharges at the medium NB or NB+ICRF heating power for which the strongly peaked electron

density profile was sustained within 0.5 sec after a series of pellet injection. The improved discharges are characterized by the pressure profile strongly peaked around the magnetic axis and degraded when a large sawtooth reappears or the pressure gradient may reach a critical value. (author).

48655 (LA-UR–89-2687) **A fully electromagnetic hybrid model for high density plasma simulations.** Jones, M.E.; Thomas, V.A.; Mason, R.J.; Winske, D. Los Alamos National Lab., NM (USA). 1989. 5p. Sponsored by U.S. DOE Defense Programs. (CONF-890931–5: 13. conference on the numerical simulation of plasmas, Santa Fe, NM (USA), 17-20 Sep 1989). Order Number DE89016771/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

Hybrid simulation methods in which ions are treated by particle-in- cell and electrons are treated as a massless fluid have proven to be useful for modeling a variety of low frequency plasma phenomena. In addition to the massless electron approximation, usually the models assume quasineutrality and the Darwin approximation to Maxwell's equations. We have considered a hybrid model in which the Darwin approximation is not used. Rather the full set of Maxwell's equations are solved. This model appears to particularly suited to modeling situation in which the plasma has a finite extent i.e., where high density plasma is next to vacuum. This model allows electromagnetic waves to propagate in the vacuum and to be properly handled in the plasma. 5 refs., 1 fig.

48656 (LA-UR–89-2710) **Solid fiber Z-pinches: "Cold-start" computations.** Lindemuth, I.R. Los Alamos National Lab., NM (USA). 1989. 11p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-890454–1: 2. international conference on high-density plasmas, Laguna Beach, CA (USA), 24-28 Apr 1989). Order Number DE89016768/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

One- and two-dimensional magnetohydrodynamic computations have been performed to study the behavior of solid deuterium fiber Z-pinch experiments performed at Los Alamos and the Naval Research Laboratory. The computations use a tabulated atomic data base and "cold-start" initial conditions. The computations predict that the solid fiber persists longer in existing experiments than previously expected and that the discharge actually consists of a relatively low-density, hot plasma which has been ablated from the fiber. The computations exhibit m = 0 behavior in the hot, exterior plasma prior to complete ablation of the solid fiber. The m = 0 behavior enhances the fiber ablation rate. 10 refs., 5 figs.

48657 (N–89-21658) **Space plasma contractor research, 1988. Annual report, 1 January 1988-1 January 1989.** Williams, J.D.; Wilbur, P.J. Colorado State Univ., Fort Collins, CO (USA). Feb 1989. 61p. (NASA-CR–182283;NAS–1.26:182283). Available from NTIS, PC A04/MF A01.

Results of experiments conducted on hollow cathode-based plasma contractors are reported. Specific tests in which attempts were made to vary plasma conditions in the simulated ionospheric plasma are described. Experimental results showing the effects of contractor flowrate and ion collecting surface size on contactor performance and contactor plasma plume geometry are presented. In addition to this work, one-dimensional solutions to spherical and cylindircal space-charge limited double-sheath problems are developed. A technique is proposed that can be used to apply these solutions to the problem of current flow through elongated double-sheaths that separate two cold plasmas. Two conference papers which describe the essential features of the plasma contacting process and present data that should facilitate calibration of comprehensive numerical models of the plasma contacting process are also included.

48658 (ORNL/FTR–2877) **[Carbon and oxygen collision data for fusion plasma research]: Foreign trip report, May 7–May 15, 1988.** Phaneuf, R.A. Oak Ridge National Lab., TN (USA). 31 May 1988. 20p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017449/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The objective of the Consultants' meeting on "Atomic Data and Fusion Applications Interface" was to establish a universal working format for computer storage and exchange of numerical atomic data among data centers and plasma physicists. A comprehensive data base program, "ALADDIN," was developed by R. A. Hulse of PPPL specifically for this purpose, and a working prototype was demonstrated. A unanimous agreement was reached to adopt the ALADDIN system on a trial basis. The IAEA Atomic and Molecular Data Unit will establish a comprehensive numerical data base and will coordinate the future exchange of data among data centers and plasma physicists. The objective of the Specialists' meeting on "Carbon and Oxygen Collision Data for Fusion Plasma Research" was to critically review the existing data base for such processes, to communicate new data, and to identify specific data requirements for future research. While the existing data base for carbon and oxygen is extensive, experimental and theoretical work is still needed on radiative and dielectronic recombination and heavy-particle excitation/ionization at low energies. Experimental data are also needed to test theoretical electron-impact excitation data for the lower charge states, where resonance effects are predicted by theory to be large.

48659 (PPPL–2639) **Comparison of ballooning mode stability properties of tokamaks with circular and elliptic cross sections with the same poloidal flux.** Miller, A.; Manickam, J.; Johnson, J.L. Princeton Univ., NJ (USA). Plasma Physics Lab. Aug 1989. 14p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE89016955/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The MHD ballooning mode stability limits for tokamak configurations with different cross section shapes but the same total poloidal flux are surprisingly similar. 8 refs., 8 figs.

48660 (PPPL–2644) **Image simulation using LOCUS.** Strachan, J.D.; Roberts, J.A. Princeton Univ., NJ (USA). Plasma Physics Lab. Sep 1989. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH03073. Order Number DE89017747/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The LOCUS data base program has been used to simulate images and to solve simple equations. This has been accomplished by making each record (which normally would represent a data entry)represent sequenced or random number pairs.

48661 (UCRL–21225) **Wave particle interactions: Final report, November 6, 1987–October 31, 1988.** Joshi, Chan. Lawrence Livermore National Lab., CA (USA); California Univ., Los Angeles, CA (USA). Dept. of Electrical Engineering. Apr 1989. 107p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE89017527/JAW. Available from NTIS, PC A07/MF A01 - OSTI; GPO Dep.

A three dimensional simulation technique, which incorporates the random selection of electron initial coordinates and momenta, has been used to model the motion of energetic electrons which are injected colinearly into a relativistic plasma wave. The model predicts the resulting energy spectrum, angular distribution, number density and spatial positions of electrons which exchange energy with the plasma wave. These predictions are applicable to the laser-plasma beatwave experiments at UCLA which use CO_2 laser wavelength 9.6 and 10.3 microns. Some of the predictions are applicable to beatwave experiments at Rutherford Laboratories which use Nd:glass laser wavelength of 1.06 and 1.05 microns and for experiments that may use 10.3 and 10.6 micron wavelengths. These experiments differ according to the phase velocity of the plasma wave produced by the beating of the two laser beams in a resonant density plasma. The predictions of this model have been useful for optimizing the electron detection apparatus of the UCLA experiments.

48662 (UCRL–101322) **An electromagnetic finite element particle code on an unstructured grid.** Ambrosiano, J.; Lohner, R. Lawrence Livermore National Lab., CA (USA). Jun 1989. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890931–8: 13. conference on the numerical simulation of plasmas, Santa Fe, NM (USA), 17-20 Sep 1989). Order Number DE89017532/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The need to perform plasma simulations in bounded regions of possibly complicated shape has generated a great deal of interest in nontraditional formulations of particle codes. Well-established methods based on rectangular Cartesian grids are too inflexible to

fit complex geometries well. Some of the unconventional approaches taken thus far include curvilinear coordinates, finite volume formulations and finite element methods. One of the most promising new strategies, in terms of geometrical flexibility, is to use unstructured grids. A structured grid connects each node to a fixed number of neighboring nodes. This makes it easy to specify the relationship between a node and its neighbors, but also makes it difficult to map such a grid into complicated geometries without patching several grids together into a composite. In contrast, one may form an unstructured grid by placing nodes anywhere in the domain as required by the shape of the boundary or the demands of the calculation. There are two obvious difficulties that occur when one abandons structured grids: solving the field equations, and locating the particles. In this paper we describe work in progress at Lawrence Livermore National Laboratory to develop a two-dimensional electromagnetic particle code on an unstructured grid. We discuss methods for obtaining the fields and for tracing the particles. 9 refs., 1 fig.

48663 (UCRL–101395) **Temporal and spatial filtering remedies for dispersion in electromagnetic particle codes.** Rambo, P.W.; Ambrosiano, J.; Friedman, A.; Nielsen, D.E. Jr. Lawrence Livermore National Lab., CA (USA). Jul 1989. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890931–7: 13. conference on the numerical simulation of plasmas, Santa Fe, NM (USA), 17-20 Sep 1989). Order Number DE89017534/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

There has been considerable interest over the last decade in the physics of intense electromagnetic signals in plasmas – much of it in the context of laser fusion and pulsar astrophysics. Simulations of these phenomena test the limits of particle simulation and in particular the standard leapfrog algorithm for advancing the electromagnetic fields. As shock fronts and sheaths develop within the plasma in response to intense electromagnetic waves, numerical dispersion in trinsic to the leapfrog algorithm can cause unphysical ripples to appear in the field solution which can interact with particles. Fourier analysis of the leapfrog scheme in 1D yields the dispersion relation for a Courant number $\nu \equiv c\Delta t/\Delta x = 0.5$. As we can see, the phase velocity of the modes falls off the light line at high $k\Delta x$. Thus modes that are poorly resolved will tend to disperse and trail the main pulse as ripples. There are several approaches to finding a remedy for these ripples. High-order finite difference methods can be considerably less dispersive. Also, improving resolution can move the physics to lower $k\Delta x$ where the dispersion is less. Often these options are not available, either because of difficulty in implementation or because computer resources are insufficient. This leaves filtering as the main option, with two routes to schemes that remove high $k\Delta x$ modes – temporal and spatial filtering. In this paper we present techniques to remove dispersion from particle simulations using both methods. 5 refs., 1 fig.

48664 **Tokamaks.** Wesson, J. 309p. Oxford University Press, New York, NY (1987).

The word tokamak derives from the Russian term, toroidalnaya kamera magnitaya (toroidal chamber magnetic). The device was invented in the Soviet Union in 1950 and has since developed into one of the chief ways in which it is hoped to obtain usable power from plasmas through thermonuclear fusion. The present is meant to be an introduction to those entering the field, to those already engaged in research, and to those who want to gain some understanding of what it's all about.

48665 **High-gain plasma Cerenkov Maser.** Garate, E.P. (California Univ., Irvine, CA (USA). Dept. of Physics); Fisher, A.; Main, W. *IEEE (Institute of Electrical and Electronics Engineers) Journal of Quantum Electronics (USA),* 25(7): 1712-1719 (Jul 1989).

The linearized fluid and Maxwell's equations are used to calculate the dispersion relation for the transverse magnetic modes of a partially filled, plasma-lined, cylindrical waveguide interacting with a relativistic electron beam. Both the plasma liner and the electron beam are assumed to be cold and the system is immersed in an infinite axial magnetic guide field. The dispersion relation is then used to calculate the growth rate for the instability between the slow-wave modes (Trivelpiece-Gould modes) of the plasma guide and the slow-pace charge mode of the electron beam. The calculation is done in the high-gain, strong coupling limit.

7002 Fusion Power Plant Technology

Refer also to citation(s) 47166, 48664

48666 (ANL/FPP/TM–242) **Erosion/redeposition analysis of the ITER [International Tokamak Engineering Reactor] divertor.** Brooks, J.N. Argonne National Lab., IL (USA). Fusion Power Program. Jul 1989. 30p. Sponsored by U.S. DOE Energy Research. DOE Contract W-31109-ENG-38. Order Number DE89016704/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Sputtering erosion of the proposed ITER divertor has been analyzed using the REDEP computer code. A carbon coated plate at medium and low plasma edge temperatures, as well as beryllium and tungsten plates, have been examined. Peak net erosion rates for C and Be are very high (~20–80 cm/burn·yr) though an order of magnitude less than the gross rates. Tritium buildup rates in codeposited carbon surface layers may also be high (~50–250 kg/burn·yr). Plasma contamination, however, from divertor sputtering is low ($\lesssim$.5%). Operation with low Z divertor plates, at high duty factors, therefore appears unacceptable due to erosion, but may work for low duty factor (~2%) "physics phase" operation. Sweeping of the poloidal field lines at the divertor can reduce erosion, by typical factors of ~2–8. A tungsten coated plate works well, from the erosion standpoint, for plasma plate temperatures of ~40 eV or less. 18 refs., 11 figs., 3 tabs.

48667 (BNL–43062) **Muon catalyzed fusion in plasma state and high intensity DT fusion neutron source.** Takahashi, Hiroshi. Brookhaven National Lab., Upton, NY (USA). 1989. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC02-76CH00016. (CONF-890711–3: 5. international conference on emerging nuclear energy systems: ICENES '89, Karlsruhe (Germany, F.R.), 3-6 Jul 1989). Order Number DE89017602/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

$dt\mu$ molecular formation rates in a plasma state of DT mixture by d and t ions are, respectively, 63 and 77 times higher than the ones by electrons. High plasma oscillation frequency in a high electron density plasma enhances the formation rate in the high temperature dt mixture. The DT muon catalyzed fusion has the ability to produce much higher intensity 14 MeV neutron source (in order of 5×10^{16}n/cm^2/sec) than other means of stripping and spallation approaches. Such neutrons can be used for testing of first wall material candidates for magnetic fusion reactors, for incinerating fission products (e.g., Cs^{137}) and for creating high thermal flux neutron sources, on the order of 10^{17}n/cm^2/sec. 12 refs., 2 figs.

48668 (CONF-890703–18) **Extraction induced emittance growth for negative ion sources.** Whealton, J.H.; Meszaros, P.S.; Raridon, R.I.; Rothe, K.E. Oak Ridge National Lab., TN (USA). 1989. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From International conference on ion sources; Berkeley, CA (USA); 9-15 Jul 1989. Order Number DE89017586/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Nonlinear emittance growth produced by ion extraction is considered by a 3-D analysis in a Vlasov-Poisson-Boltzmann formulation. Phenomena considered include: presheath effects, including electron depletion, electron sheath accumulation (for large transverse magnetic fields), nonlinear sheath fields (obtained by a self-consistent solution with an assumed quasi-equilibrium positive ion distribution and at least one Vlasov distribution), nonlinear fringe fields produced by the accelerator-extractor itself obtained self-consistently with item 3 above, nonlinear space charge of the beam itself, and beam in conjunction with extracted electrons. For specific volume negative ion source configurations, an investigation of the contribution of aberrations caused by an electron trap and electron accumulation in the extraction sheath are studied. Either of these effects can contribute significantly to the beam emittance, possibly dominating the contribution of the negative ion temperature in the source. 2 refs., 10 figs.

48669 (CONF-8902118–3) **Need for and requirements for neutron irradiation facility for fusion materials testing.** Ishino,

S.; Schiller, P.; Rowcliffe, A.F. Oak Ridge National Lab., TN (USA). 1989. 27p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From International Energy Agency workshop on fusion materials irradiation facilities; San Diego, CA (USA); 14-17 Feb 1989. Order Number DE89017574/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

The construction and operation of an intense 14MeV neutron source is essential for the development and eventual qualification of structural materials for a fusion reactor demonstration plant (DEMO). Because of the time required for materials developed and the scale-up of materials to commercial production, a decision to build a neutron source should precede engineering design activities for a DEMO by at least 20 years. The characteristic features of 14MeV neutron damage are summarized including effects related to cascade structure, transmutation production, and dose rate. The importance of a 14MeV neutron source for addressing fundamental radiation damage issues, alloy development activities and the development of an engineering data bases is discussed. From these considerations the basic requirements and machine parameters are derived. 14 refs., 5 figs., 5 tabs.

48670 (CONF-8909184–1) **Rational design of high-current cable-in-conduit superconductors.** Dresner, L. Oak Ridge National Lab., TN (USA). 1989. 21p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From IAEA specialists meeting on superconducting materials and magnets; Tokyo (Japan); 4-6 Sep 1989. Order Number DE89016867/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Cable-in-conduit superconductors are composed of a cable of many fine composite strands encased in a strong, protective jacket, with helium coolant filling the interstices of the cable. Because of the high degree of subdivision of the composite and its consequent large cooled surface, such conductors are capable of stable operation at quite high current densities. The designer of such conductors is frequently given the field at the conductor and the overall current density and asked to specify the remaining variables of the conductor (e.g., the strand diameter, the hydraulic path length, the void fraction of the cable, and the Cu/SC ratio). This paper outlines a rational procedure for determining the most problematic variables, the two composition variables that determine the proportions of copper, superconductor, and helium in the cable space. All other variables of the conductor are assumed known. 14 refs., 8 figs.

48671 (DOE/DP/10618–T2) **Generation and focusing of pulsed intense ion beams: Final report, 1 July 1987–30 September 1988.** Hammer, D.A.; Kusse, B.R.; Sudan, R.N. Cornell Univ., Ithaca, NY (USA). Lab. of Plasma Studies. 3 Aug 1989. 6p. Sponsored by U.S. DOE Defense Programs. DOE Contract FC08-87DP10618. Order Number DE89017558/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper discusses the following experiments: ion diode experiments at 0.5×10^{12} W on the LION accelerator; spectroscopic studies of ion diodes; ion beam-plasma channel transport research; and plasma opening switch experiments.

48672 (DOE/ER/52122–4) **High power microwave transmission systems for electron cyclotron resonance plasma heating: Volume IV, Progress report, September 1, 1988–August 31, 1989.** Vernon, R.J. Wisconsin Univ., Madison, WI (USA). Dept. of Electrical and Computer Engineering. Aug 1989. 43p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-85ER52122. Order Number DE89017314/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

This progress report is for the fourth year of a grant from the US Department of Energy for the design, development, and fabrication of ECRF transmission and mode conversion systems to transport microwave power from a gyrotron to a magnetically confined plasma. The development and testing of new and improved components for such systems and underlying theory, where necessary, is the focus of this project. Devising and improving component testing and diagnostic techniques is also an important part of this effort. During the last year, we developed a preliminary design for a $Te_{15,2}$–$TE_{15,1}$ mode converter for the MIT 150 GHz gyrotron and considered its performance as the frequency and mode was step tuned. A preliminary design for a combined uptaper and $TE_{15,2}$–$TE_{15,1}$ converter for possible use with the Varian 140 GHz gyrotron was also developed. Work was begun on a combined $TE_{15,n}$ uptaper – mode converter to produce a mode combination which would reduce microwave radiation into an azimuthal waveguide gap. Simple models for the radiation from TE_{0n} and TM_{0n} Vlasov launcher baffles were developed and compared with measurements which were taken in our radiation pattern measurement facility. Work began on testing possible methods for generating high azimuthal index rotating modes. Work on the further refinement of the method of mode content determination from open-end radiation pattern measurement was carried out. An investigation of the Wiener-Hopf method for obtaining open- end radiation patterns produced improved radiation patterns for the TE_{0n} modes in a circular waveguide. 15 refs., 15 figs.

48673 (INIS-mf–11515, pp. 79) **Experimental investigations on muon-catalyzed nuclear fusion.** Ackerbauer, P. (Oesterreichische Akademie der Wissenschaften, Vienna (Austria)); Breunlich, W.H.; Fuchs, M. and others. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48674 (INIS-mf–11515, pp. 80) **Search for crystal-catalyzed fusion reactions.** Badurek, G. (Atominstitut der Oesterreichischen Universitaeten, Vienna (Austria)); Rauch, H.; Seidl, E. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48675 (INIS-mf–11515, pp. 106) **Data libraries for fusion reactions in fusion fuels.** Feldbacher, R. (Technische Univ., Graz (Austria). Inst. fuer Theoretische Physik und Reaktorphysik). Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48676 (INIS-mf–11515, pp. 107) **Reaction rates in cold fusion.** Oberhummer, H. (Techn. Univ. Vienna, Inst. fuer Kernphysik, Vienna (Austria)); Gruen, K.; Leeb, H. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48677 (INIS-mf–11515, pp. 127) **Transferreactions at thermonuclear energies.** Bach, B. (Techn. Univ. Vienna, Inst. fuer Kernphysik, Vienna (Austria)); Herndl, H.; Oberhummer, H.; Rauscher, T. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48678 (INIS-mf–11515, pp. 128) **Measurement of sticking probability in muon-catalysed fusion.** Ackerbauer, P. (Oesterreichische Akademie der Wissenschaften, Vienna (Austria)); Breunlich, W.H.; Fuchs, M. and others. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48679 (INIS-mf–11515, pp. 106) **D-^{3}He as fusion fuel.** Heindler, M. (Technische Univ., Graz (Austria). Inst. fuer Theoretische Physik und Reaktorphysik); Kernbichler, W.; Miley, G.H. Johannes Kepler Univ., Linz (Austria). 1989. (In German). (CONF-8909194–: Annual convention of the Austrian physical society, Linz (Austria), 25-29 Sep 1989). In *Annual convention 1989 of the Austrian physical society.* Order Number DE90600715/JAW. Available from NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS.

Published in summary form only.

48680 (INIS-mf–11537, pp. 79) **Prospects for fusion power: recent reports in Europe.** Ford, G.W.K. (New South Wales Univ., Kensington (Australia). School of Mechanical and Industrial Engineering). Australian Inst. of Nuclear Science and Engineering, Lucas Heights (Australia). 1989. (CONF-8902130–: 17. AINSE plasma physics conference, Lucas Heights (Australia), 6-8 Feb 1989). In *17th AINSE plasma physics conference: conference handbook.* Order Number DE90600936/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

Abstract only.

48681 (INIS-mf–11537, pp. 11) **Great stellarator revival.** Hamberger, S.M. (Australian National Univ., Canberra (Australia). Plasma Research Lab.). Australian Inst. of Nuclear Science and Engineering, Lucas Heights (Australia). 1989. (CONF-8902130–: 17. AINSE plasma physics conference, Lucas Heights (Australia), 6-8 Feb 1989). In *17th AINSE plasma physics conference: conference handbook.* Order Number DE90600936/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

Abstract only.

48682 (INIS-mf–11537, pp. 13) **Electron-beam measurements of the magnetic surfaces in SHEILA.** Tou, T.Y. (Australian National Univ., Canberra (Australia). Plasma Research Lab.); Blackwell, B.D.; Sharp, L.E. Australian Inst. of Nuclear Science and Engineering, Lucas Heights (Australia). 1989. (CONF-8902130–: 17. AINSE plasma physics conference, Lucas Heights (Australia), 6-8 Feb 1989). In *17th AINSE plasma physics conference: conference handbook.* Order Number DE90600936/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

Abstract only.

48683 (INIS-mf–11537, pp. 56) **Past two years of laser fusion.** Luther-Davies, B. (Australian National Univ., Canberra (Australia). Laser Physics Centre). Australian Inst. of Nuclear Science and Engineering, Lucas Heights (Australia). 1989. (CONF-8902130–: 17. AINSE plasma physics conference, Lucas Heights (Australia), 6-8 Feb 1989). In *17th AINSE plasma physics conference: conference handbook.* Order Number DE90600936/JAW. Available from NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS.

Abstract only.

48684 (IPPJ–902) **Unlimited acceleration of particles by a system of multi-laser beams.** Sugihara, Ryo. Nagoya Univ. (Japan). Inst. of Plasma Physics. Mar 1989. 19p. Order Number DE90701757/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

A new scheme of particle acceleration is proposed in which an electron (or a positron) can coherently interact with a system of multi-laser beams. The system can trap and accelerate the particle obliquely to the direction of the beams, the principle being analogous to the V_p x B or the cross field acceleration. It is demonstrated that if the electric field of an individual laser beam is 10^{12} V/cm we may have a 1 TeV electron with a 2 m long device in a static magnetic field less than 20 tesla. (author).

48685 (IPPJ-DT–145) **Development of the monitoring system for the JIPPT-IIU operation.** Taniguchi, Y.; Kojima, M.; Hidekuma, S. Nagoya Univ. (Japan). Inst. of Plasma Physics. Feb 1989. 40p. (In Japanese). Order Number DE90701616/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

The monitoring system for the JIPPT-IIU operation has been developed using a personal computer. This system provides shot number, count down, and the output of flywheel to fourdisplays located at different places for our convenience. It also sends these parameters to three independent data acquisition systems to identify the discharge in the JIPPT-IIU tokamak. (author).

48686 (JAERI-M–89-028) **Study on poloidal field coil optimization and equilibrium control of ITER.** Shinya, Kichiro; Sugihara, Masayoshi; Nishio, Satoshi. Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1989. 62p. Order Number DE90701678/JAW. Available from NTIS (US Sales Only), PC A04/MF A01.

The purpose of this report is to present general features of the poloidal field coil optimization for the ITER plasma, flexibility analysis for various plasma options and some other aspect of the equilibrium control which is required for understanding plasma operation in more detail. Double null divertor plasma was selected as a main object of the optimization. Single null divertor plasma was assumed to be an alternative, because single null divertor plasma can be operational within the amounts of the total stored energy and ampere-turns of the double null divertor plasma, if it is shaped appropriately. Plasma parameters used in the present analysis are mainly those employed in the preliminary study by the Basic Device Engineering group of the ITER design team. The most part of the optimization study, however, utilizes the parameters proposed for discussion by the Japan team before starting joint design work at Garching. Plasma shape, and solenoid coil shape and size, which maximize available flux swing with reasonable amounts of the stored energy and ampere-turns, are discussed. Location and minimum number of the poloidal field coils with adequate shaping controllability were also discussed for various plasma options. Some other aspect of the equilibrium control, such as separatrix swing, moving null point operation during plasma heating and possible range of li, were evaluated and the guideline for the engineering design was proposed. Finally, fusion power output was estimated for the different pressure profiles and combinations of the average density and temperature, and the magnetic quantities of the scrape-off region was calculated to be available for the future divertor analysis. (author).

48687 (JAERI-M–89-040) **Thermal design of a 10-kW helium refrigerator.** Yamamura, Hidemasa; Kato, Takashi; Tada, Eisuke; Hiyama, Tadao; Kawano, Katsumi; Sato, Masahiko; Shimamoto, Susumu. Japan Atomic Energy Research Inst., Tokyo (Japan). Mar 1989. 41p. (In Japanese). Order Number DE90701785/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

The Proto Toloidal Coil program, which is to develop the large superconducting toloidal coil for the Fusion Experimental Reactor (FER), is being investigated. In this program, construction of the 10-kW helium refrigeration system is indispensable. This paper describes the optimized system design of 10-kW helium refrigerator based on the thermal analysis. In addition, the key items to be developed for the large scale heium refrigerator (30 kW x 4 units) of the FER are described. (author).

48688 (ORNL/FTR–2843) **[International symposium on fusion nuclear technology, Tokyo, Japan, April 10, 1988]: Foreign trip report.** Bell, G.E. Oak Ridge National Lab., TN (USA). 24 May 1988. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017288/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A presentation entitled "Experimental and Analytical Investigations of Mass Transfer Processes of ^{12}Cr-1MoVW Steel in Thermally-Convected Lithium Systems" was made by G.E. Bell [coauthors M.A. Abdou (UCLA) and P.F. Tortorelli (ORNL)] at a poster session of the International Symposium on Fusion Nuclear Technology (ISFNT). The results presented were taken from work performed while Mr. Bell was an Oak Ridge Associated Universities Fellow at ORNL from October 1986 to March 1988. A consistent theme throughout the conference was the need for collaboration within and among national efforts to achieve the goal of an engineering test reactor.

48689 (ORNL/FTR–3131) **[Reactor irradiation techniques]: Foreign trip report, November 7–11, 1988.** Thoms, K.R,. Oak Ridge National Lab., TN (USA). 28 Nov 1988. 15p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. Order Number DE89017417/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The traveler participated in the Japan/US Workshop on Reactor Irradiation Techniques presenting two papers and serving as chairman of a session. The workshop centered on techniques related to fusion materials research and offered an opportunity to describe

ORNL reactor facilities to this community. The traveler also visited the reactor and hot cell facilities at the PNC, Tohoku University, and JAERI sites located at Oarai, Japan. These visits provided insight into operating techniques at reactor and hot cell facilities similar to those at ORNL.

48690 (SAND–89-0139C) **Lifetime testing of commercially available 3.0 μf, 100 kV pulsed-power capacitors.** Schneider, L.X.; Babcock, S.R.; Laderach, G.E. Sandia National Labs., Albuquerque, NM (USA). [1989]. 5p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-890665–44: 7. Institute of Electrical and Electronics Engineers pulsed power conference, Monterey, CA (USA), 12-14 Jun 1989). Order Number DE89017230/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

The lifetime characteristics of a small sample group of commercially available 3.0-μF, 100-kV pulsed-discharge capacitors have been determined in an automated test facility. Both Maxwell Laboratories and Aerovox, Inc., capacitors were tested to failure to establish a data base on these new designs, which are a direct physical replacement for the present 1.3-μF, 100-kV, Syllac-style capacitor that are in wide spread use at Sandia and in the pulsed-power community. In conjunction with the lifetime testing a bipolar, 30-stage, 6-MV, Marx generator was constructed with these capacitors using conventional PBFA-II hardware and the Physics International Company, model T-508A spark gap. Capacitor failure mechanisms and lifetime statistics will be discussed. Electrode erosion rates in the 508A switches will be presented for the conventional brass electrodes and a copper/tungsten replacement set. 5 refs., 5 figs., 3 tabs.

48691 (SAND–89-0283C) **Launched electrons in plasma opening switches.** Mendel, C.W. Jr.; Rochau, G.E.; Sweeney, M.A.; McDaniel, D.H.; Quintenz, J.P.; Savage, M.E.; Lindman, E.L.; Kindel, J.M. Sandia National Labs., Albuquerque, NM (USA). [1989]. 26p. Sponsored by U.S. DOE Energy Research. DOE Contract AC04-76DP00789. (CONF-8906208–1: International workshop on physics and techniques of high power opening switches, Novosibirsk (USSR), 30 Jun - 2 jul 1989). Order Number DE89016886/JAW. Available from NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.

Plasma opening switches have provided a means to improve the characteristics of super-power pulse generators. Recent advances involving plasma control with fast and slow magnetic fields have made these switches more versatile, allowing for improved switch uniformity, triggering, and opening current levels that are set by the level of auxiliary fields. Such switches necessarily involve breaks in the translational symmetry of the transmission line geometry and therefore affect the electron flow characteristics of the line. These symmetry breaks are the result of high electric field regions caused by plasma conductors remaining in the transmission line, ion beams crossing the line, or auxilliary magnetic field regions. Symmetry breaks cause the canonical momentum of the electrons to change, thereby moving them away from the cathode. Additional electrons are pulled from the cathode into the magnetically insulated flow, resulting in an excess of electron flow over that expected for the voltage and line current downstream of the switch. We call these electrons "launched electrons". Unless they are recaptured at the cathode or else are fed into the load and used beneficially, they cause a large power loss downstream. This paper will show examples of SuperMite and PBFA II data showing these losses, explain the tools we are using to study them, and discuss the mechanisms we will employ to mitigate the problem. The losses will be reduced primarily by reducing the amount of launched electron flow. 7 refs., 9 figs.

48692 (SAND–89-1270C) **Pulsed-power switching for inertial confinement fusion with light ion beams.** Vandevender, J.P.; Buttram, M.T.; Harjes, H.C.; Johnson, D.L.; Martin, T.H.; Neau, E.L.; Prestwich, K.R.; Ramirez, J.J.; Rohwein, G.J.; Schneider, L.X. Sandia National Labs., Albuquerque, NM (USA). [1989]. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. (CONF-890796–3: International workshop on high power opening switches, Novosibirsk (USSR), 1-2 Jul 1989). Order Number DE89016810/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Inertial confinement fusion requires 100 to 1000 terawatts of power be generated by sequentially storing and switching between 2 and 4 megajoules of energy to compress the pulse duration to approximately 10 ns. The status and promise of the switching technologies for light-ion driven inertial fusion are presented. Experiments on the Particle Beam Fusion Accelerator II (PBFA II) at Sandia National Laboratories will attempt to find the threshold for igniting thermonuclear fuel in the laboratory and – if the threshold is within the range of PBFA II experiments – to achieve ignition. These experiments are possible because of advances in electrically triggered and laser-triggered gas switching and in untriggered water-dielectric switching. The advances permit reliable operation of the 36-module PBFA II with module jitters of 4 ns and first-to-last spreads of 15 ns. The modules are combined in series and parallel combinations to give an effective asynchrony of ~ 1 ns. The next major facility in the inertial fusion program will be the Laboratory Microfusion Facility for producing 200 to 1000 megajoules of thermonuclear yield. The laser-triggered gas switching and water-dielectric switching demonstrated on the Hermes III accelerator are adequate for this next step. The high efficiency and low cost of large pulsed-power accelerators result in a low cost reactor concept. Development of the high average power and high peak power necessary for 3- to 5-Hz operation will require further advances in high power switching. Saturable inductors offer a promising option. Photo-conductive semi-conductor switching offer the possibility of substantially reducing the number of required pulse compression stages. 22 refs., 3 figs.

48693 (UCID–21519-Rev.1) **Projections for a steady-state tokamak reactor based on ITER.** Devoto, R.S.; Barr, W.L.; Bulmer, R.H.; Campbell, R.B.; Fenstermacher, M.E.; Lee, J.D.; Logan, B.G.; Miller, J.R.; Reginato, L.L.; Krakowski, R.A. Lawrence Livermore National Lab., CA (USA). 20 Jul 1989. 64p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. Order Number DE89016678/JAW. Available from NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.

The extensions of the physics and engineering guidelines for the ITER device needed for acceptable operating points for a steady-state tokamak power reactor are examined. Non-inductive current drive is provided in steady state by high-energy neutral-beam injection in the plasma core, lower-hybrid slow waves in the outer regions of the plasma and (30%) bootstrap current. Three different levels of extension of the ITER physics/engineering guide-lines, with differing assumptions on the possible plasma beta, elongation and aspect ratio, are considered for power-reactor applications. Plasma gain, Q_p = fusion power/input power, in excess of 20 and average neutron wall fluxes from 2.3 to 3.6 MW/m^2 are predicted in devices with major radii varying from 7.0 to 6.0 m and aspect ratios from 2.9 to 4. 3. Peak divertor heat fluxes range up to 12.2 MW/m^2 which is somewhat higher than the current ITER design limit of 10 MW/m^2 with a magnetically swept divertor. These designs were selected on the basis of improvements in physics/engineering consistent with time scales for development of future reactors. The design re-optimization on the basis of cost-of-electricity (COE) was then examined using a reactor systems model. This analysis generally verified the original estimates for the required extensions of the ITER guidelines. Cost of electricity is projected to be less than 66 mills/kW$_e$h in all of the configurations. The smallest reactor, which has the largest neutron wall flux and mass power density, yields the lowest COE, 56 mills/kW$_e$h. 37 refs., 8 figs., 11 tabs.

48694 (UCID–21737) **Testing results of the MIT Probe.** Shen, S.S.; Chaplin, M.R. Lawrence Livermore National Lab., CA (USA). 11 Aug 1989. 18p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. Order Number DE89016679/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The MIT Probe is a non-inductively wound coil of Cable-in-Conduit Conductor (CICC) designed and fabricated by the MIT Plasma Fusion Center for testing at the High-Field Test Facility (HFTF) as a cooperative testing of high-current conductors for fusion applications. Test objectives mainly include measurement of Lorentz-force degradation in such practical conductors. The probe was received in January 1988. It first went through a series of checkouts and was then connected to a 40-kA power-supply system and installed in HFTF. Testing of the probe started on May 12,

1989, and ended on June 16, 1989. This report summarizes results of all tests performed at LLNL. 12 figs.

48695 (UCRL–100530) **The International Thermonuclear Experimental Reactor (ITER): Design and materials selection.** Summers, L.T.; Miller, J.R.; Heim, J.R. Lawrence Livermore National Lab., CA (USA). 8 Aug 1989. 9p. Sponsored by U.S. DOE Energy Research. DOE Contract W-7405-ENG-48. (CONF-890701–4: International cryogenic materials conference, Los Angeles, CA (USA), 24-28 Jul 1989). Order Number DE89017759/JAW. Available from NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.

The success of ITER relies on aggressive design of the superconducting magnet systems. This design emphasized high radiation-damage tolerance, acceptance of high nuclear heat loads, and high operational stresses in the Toroidal Field (TF) magnets. The design of the Central Solenoid (CS) magnets, although they will be well shielded from the plasma, is equally aggressive due to the need for very high magnetic fields (14 T) and long term operation at high cyclic stresses. Success of these magnet designs depends, in part, on sound selection and fabrication of materials for structural, superconducting, and insulating components. Here we review the design of ITER and the selection of structural materials for some of the systems that will operate at cryogenic temperatures. In addition we will introduce some of the data that the materials selection is based on and suggest opportunities for future research in support of ITER. 10 refs., 1 fig., 4 tabs.

48696 (UCRL–101646) **High pressure, energy, and impulse loading of the wall in a 1-GJ Laboratory Microfusion Facility.** Harrach, R.J. Lawrence Livermore National Lab., CA (USA). 24 Jul 1989. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. (CONF-890812–44: American Physical Society topical conference on shock compression of condensed matter, Albuquerque, NM (USA), 14-17 Aug 1989). Order Number DE89017740/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

A proposed Laboratory Microfusion Facility (LMF) must be able to withstand repeated, low-repetition-rate fusion explosions at the 1-GJ (one-quarter ton) yield level. The energy release will occur at the center of a chamber only a few meters in radius, subjecting the interior or first wall to severe levels of temperature, pressure, and impulse. We show by theory and computation that the wall loading can be ameliorated by interposing a spherical shell of low-Z material between the fuel and the wall. This sacrificial shield converts the source energy components that are most damaging to the wall (soft x-rays and fast ions) to more benign plasma kinetic energy from the vaporized shield, and stretches the time duration over which this energy is delivered to the wall from nanoseconds to microseconds. Numerical calculations emphasize thin, volleyball-sized plastic shields, and much thicker ones of frozen nitrogen. Wall shielding criteria of small (or no) amount of surface ablation, low impulse and pressure loading, minimal shrapnel danger, small expense, and convenience in handling all favor the thin plastic shields. 7 refs., 4 figs.

48697 Tensile behavior of helium-implanted and neutron-irradiated V-15 Cr-5 Ti. Grossbeck, M.L. (Oak Ridge National Lab., TN (USA)); Horak, J.A. *Transactions of the American Nuclear Society (USA),* 52: 154-156 (1986). (CONF-860610–: American Nuclear Society annual meeting, Reno, NV (USA), 15-20 Jun 1986).

Vanadium alloys are being considered for use for the first-wall and blanket structures in fusion reactors due to their high melting points and low neutron activation. The allow reported on here, V-15 Cr-5 Ti, was prepared by the Westinghouse Advanced Reactors Division (Heat HSV-307). Since the fusion environment produces helium in all common structural alloys including vanadium, the effect of helium in irradiated alloys was investigated. In a fusion reactor spectrum, ≈5 at. ppm He/dpa is expected. Ideally, the helium should be produced concurrently with displacement damage. However, since this is difficult or impossible in vanadium without a source of high-energy neutrons, cyclotron implantation of helium followed by fission reactor irradiation was chosen. By this method, it was hoped to scope qualitatively the effect of helium alone and the synergistic effect of helium in conjunction with neutron irradiation. It was concluded that: 1. Cyclotron injection of 80 at. ppm He has little effect on mechanical properties of V-15 Cr-5 Ti at 700 and 625°C and causes a factor of ≈2 reduction in elongation at 400°C. 2. Neutron irradiation to 24 to 32 dpa increases the strength of annealed V-15 Cr-5 Ti by a factor or ≈2 and decreases ductility by a factor of about 10. 5 refs., 2 figs.

48698 Environmental impact of fusion power. Atkinson, A. *Energy Policy (UK),* 17(3): 277-283 (Jun 1989).

In the early years of research into fusion, a powerful impression embedded itself in the public imagination that here was a potentially infinite source of energy which, once released, would be cheap and trouble-free. As research has progressed, it has gradually become evident that a major fusion programme, if it ever becomes technically realizable, will be far from cheap. Furthermore, the notion that fusion power would be free of serious environmental problems is also showing itself to be a long way from the truth. The aim of this article is to survey the information so far available on potential environmental impacts of fusion power and then, briefly, to place this in the context of other contending long-term sources of energy. (author).

48699 STOA experiment in the European Parliament. The fusion project. Lake, G. (European Parliament, Luxembourg (Luxembourg)). *Energy Policy (UK),* 17(3): 284-288 (Jun 1989).

The European Parliament, like the US Congress before it, has recognized a need for independent advice on scientific and technological policy issues, being hitherto over-dependent on Commission expertise in its examination of Commission proposals. Accordingly, it established the STOA Project (Scientific and Technological Options Assessment) in March 1987. The first major STOA study, Criteria for the Assessment of European Fusion Research, is described and analysed. A contrast is drawn between consensual and adversarial approaches to technology assessment and the importance of open, critical debate is stressed. In conclusion, it is the social character of technology which underlies the importance of parliamentary technology assessment. (author).

48700 Single column and two-column H-D-T distillation experiments at TSTA. Yamanishi, T. (Japan Atomic Energy Research Inst., Tokai, Ibaraki (Japan)); Yoshida, H.; Hirata, S.; Naito, T.; Naruse, Y.; Sherman, R.H.; Bartlit, J.R.; Gruetzmacher, K.M.; Anderson, J.L. *Fusion Technology (USA),* 14(2): 489-494 (Sep 1988). (CONF-880505–: 3. topical meeting on tritium technology in fission, fusion and isotopic applications, Toronto (Canada), 1-6 May 1988).

Cryogenic distillation experiments were performed at TSTA with H-D-T system by using a single column and a two-column cascade. In the single column experiment, fundamental engineering data such as the liquid holdup and the HETP were measured under a variety of operational conditions. The liquid holdup in the packed section was about 10–15% of its superficial volume. The HETP values were from 4 to 6 cm, and increased slightly with the vapor velocity. The reflux ratio had no effect on the HETP under the condition that the vapor velocity was almost constant. For the two-column experiment, dynamic behavior of the cascade was observed.

48701 Operating experience with the hydrogen isotope separation system at MOUND. Embury, M.C. (Monsanto Research Corp., Miamisburg, OH (USA). Mound); Erwin, M.G.; Levan, D.A. *Fusion Technology (USA),* 14(2): 431-437 (Sep 1988). (CONF-880505–: 3. topical meeting on tritium technology in fission, fusion and isotopic applications, Toronto (Canada), 1-6 May 1988).

The Hydrogen Isotope Separation System (HISS) is a general-purpose tritium recovery and enrichment processor that uses low-temperature distillation as the separation process. HISS processes feed mixtures containing all three isotopes of hydrogen (H, D, T) and yields an enriched tritium product up to 99.95% tritium, while producing a discardable raffinate. The three-column system operates continuously with unattended overnight operation and limited operation during weekends. Production runs with a full still inventory were started in October 1987, with individual runs lasting up to seven weeks.

48702 Code development for analysis of TSTA compound cryopumps. Ashibe, K. (Toshiba Corp., Kawasaki, Kanagawa (Japan). Research and Development Center); Naruse, Y.; Walters, C.R.; Anderson, J.L. *Fusion Technology (USA),* 14(2): 546-551

(Sep 1988). (CONF-880505–: 3. topical meeting on tritium technology in fission, fusion and isotopic applications, Toronto (Canada), 1-6 May 1988).

A Monte Carlo computer code for analyzing free molecular gas flow has been developed to study the pumping characteristics of compound cryopumps for plasma chamber evacuation of fusion reactors. The code can deal with complex internal geometries of the pumps which commonly consist of cryopumping surfaces surrounded with elements like baffles, shields, and reservoirs. This code was used to study the pumping performance of a compound cryopump in the Tritium Systems Test Assembly (TSTA) at Los Alamos National Laboratory. The results show that the calculated pumping speeds are strongly effected by the geometrical models employed in the calculations, and that an analysis based on a detailed model is essential to estimate the performance of compound cryopumps.

48703 Design of the TFTR [Tokamak Fusion Test Reactor] maintenance manipulator. Loesser, G. D.; Heitzenroeder, P.; Bohme, G.; Selig, M. *Transactions of the American Nuclear Society (USA),* 55: 666 (1987). (CONF-8711195–: American Nuclear Society winter meeting, Los Angeles, CA (USA), 15-19 Nov 1987).

The Tokamak Fusion Test Reactor (TFTR) plans to generate a total of 3×10^{21} neutrons during its deuterium-tritium run period in 1900. This will result in high levels of radiation, especially within the TFTR vacuum vessel. The maintenance manipulator's mission is to assist TFTR in meeting Princeton Plasma Physics Laboratory's personnel radiation exposure criteria and in maintaining as-low-as-reasonably-achievable principals by limiting the radiation exposure received by operating and maintenance personnel. The manipulator, which is currently being fabricated and tested by Kernforschungszentrum Karlsruhe, is designed to perform limited, but routine and necessary, functions within the TFTR vacuum torus after activation levels within the torus preclude such functions being performed by personnel. These functions include visual inspection, tile replacement, housekeeping tasks, diagnostic calibrations, and leak detection. To meet its functional objectives, the TFTR maintenance manipulator is required to be operable in TFTR's very high vacuum environment (typically 2×10^{-8} Torr). It must also be bakeable at 150°C and able to withstand the radiation environment.

48704 In-vessel remote maintenance of the Compact Ignition Tokamak. Tabor, M.A.; Hager, E.R.; Creedon, R.L.; Fisher, M.V.; Atkin, S.D. *Transactions of the American Nuclear Society (USA),* 55: 668 (1987). (CONF-8711195–: American Nuclear Society winter meeting, Los Angeles, CA (USA), 15-19 Nov 1987).

The Compact Ignition Tokamak (CIT) is the first deuterium-tritium (D-T) fusion device that will study the physics of an ignited plasma. The ability of the tokamak vacuum vessel to be maintained remotely while under vacuum has not been fully demonstrated on previous machines, and this ability will be critical to the efficient and safe operation of ignition devices. Although manned entry into the CIT vacuum vessel will be possible during the nonactivated stages of operation, remotely automated equipment will be used to assist in initial assembly of the vessel as well as to maintain all in-vessel components once the D-T burn is achieved. Remote maintenance and operation will be routinely required for replacement of thermal protection tiles, inspection of components, leak detection, and repair welding activities. Conceptual design to support these remote maintenance activities has been integrated with the conceptual design of the in-vessel components to provide a complete and practical remote maintenance system for CIT. The primary remote assembly and maintenance operations on CIT will be accomplished through two dedicated 37- x 100-cm ports on the main toroidal vessel. Each port contains a single articulated boom manipulator (ABM), which is capable of accessing half of the torus. The proposed ABM consists of a movable carriage assembly, telescoping two-part mast, and articulated link sections. 1 ref.

48705 Remote leak detection for the Compact Ignition Tokamak. Fisher, M.V.; Jensen, T.H.; Hager, E.R. *Transactions of the American Nuclear Society (USA),* 55: 670-671 (1987). (CONF-8711195–: American Nuclear Society winter meeting, Los Angeles, CA (USA), 15-19 Nov 1987).

The Compact Ignition Tokamak (CIT) is the first deuterium-tritium fusion device that will study the physics of an ignited plasma. Leaks in the CIT vacuum vessel could prevent the plasma from reaching ignition conditions. Manned entry into the vacuum vessel will not be possible beyond the nonactivated stages of operation. Therefore, plans for CIT anticipate the need to repair leaks in the vacuum vessel remotely. The work described in this paper concerns a conceptual scheme of determining the approximate location of a leak. Conventional leak detection methods that require access to the outside surface of the vacuum chamber cannot be employed on CIT in part because of inaccessibility. Only methods that utilize access to the interior of the vacuum chamber were considered. An idea for such a method was developed and tested previously. The instrument, called the leak telescope can, in the parameter region of interest detects leaks behind tile at distances of ≈1 m. Another method requires the sensing instrument to be close (≈10 cm) to the leak and was therefore judged less attractive than the leak telescope. An experimental device for testing the leak telescope concept has been assembled. Models describing how the leak telescope can detect leaks located behind tiles have been experimentally verified. 3 refs., 1 fig.

99 GENERAL AND MISCELLANEOUS

48706 (PNL-SA–17193) **Applications of new technologies using a systems approach.** Watts, R.L. Pacific Northwest Lab., Richland, WA (USA). Aug 1989. 11p. Sponsored by U.S. DOE Conservation & Renewable Energy. DOE Contract AC06-76RL01830. (CONF-890814–4: American Institute of Chemical Engineer's summer national meeting, Philadelphia, PA (USA), 20-23 Aug 1989). Order Number DE89016826/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Results have far exceeded the expectations of those who initiated planning eight years ago for the US Department of Energy's (DOE's) Innovative Concepts Program (ICP). The ICP was formally launched in 1983 by DOE's Office of Energy Utilization Research when it funded the first of several experiments to develop and demonstrate methods for identifying and providing for the preliminary development of fragile new ideas for saving energy. The mission of this program is to increase the inventory of new concepts available for funding by other DOE programs and by private industry. In carrying out this mission, the ICP complements other programs designed to accelerate the process of applying new technology in industry. The ICP uses a systems approach to provide opportunity, means, and motive to potential innovators to help overcome the institutional, cultural, and motivational factors that cause a high mortality rate among new concepts. The ICP connects those who understand production and distribution and consumption problems with those who have potentially unique technology to apply to their solution. Innovators synthesize the results of their preliminary evaluations in a format found to be helpful to those who are in a position to make decisions about providing subsequent funding to further develop the concept. The innovator presents his results at a technology fair organized by the program to introduce the innovator to potential sponsors. The results also are presented in project summary reports and technical briefs. Three "experiments" have been completed to date, with 32 innovators receiving about $15,000 each from the ICP. Thirteen of the 32 innovators participating in the three completed experiments have received follow-on funding totaling more than $3,000,000. A fourth experiment is in process. 5 figs., 3 tabs.

48707 (UCID–21684) **Evaluation of an 1840A magnetic tape from Interleaf, Incorporated.** Lawrence Livermore National Lab., CA (USA); SYSCON Corp., San Diego, CA (USA). 10 Aug 1989. 19p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CTN–89-011). Order Number DE89016680/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This was a CTN Planned Test (CPT) with Interleaf, Incorporated. The objective of the test was to evaluate a magnetic tape, delivered by Interleaf, to see if the data "envelope" was consistent with MIL-STD-1840A (1840A). The test was performed to provide information and insight into the preparation and delivery of 1840A data and to identify areas of the 1840A standard that may need revision, clarification or supplementary information. The CTN-produced tool, TAPEVAL, was used to verify the data envelope.

48708 (UCID–21723) **A model to calculate effectiveness of a submarine-launched nuclear ASW weapon.** Magnoli, D.E. Lawrence Livermore National Lab., CA (USA). Jun 1989. 7p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE89017750/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

LLNL's Navy Tactical Applications Group (NTAG) has produced a computer model to calculate the probability of kill of a submarine-launched nuclear ASW standoff-weapon. Because of the uncertainties associated with target position and motion and with weapon delivery, this is a problem appropriately treated statistically. The code is a Monte Carlo's simulation which follows the engagement from localization through optional evasive maneuvers of the target to attack and damage assessment. For a given scenario (weapon characteristics, target characteristics, firing platform depth and hardness, etc.) the code produces a table and ultimately a plot of Pk as a function of range. 2 figs., 1 tab.

9901 Management

Refer also to citation(s) 47088, 48741

48709 (INIS-mf–11532) **ANSTO strategic plan 1988-1993.** Australian Nuclear Science and Technology Organisation, Lucas Heights (Australia). Dec 1988. 36p. Order Number DE90601776/JAW. Available from NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS.

This Strategic Plan outlines the development of the Australian Nuclear Science and Technology Organisation in the five year period 1988/89-1992/93. Its formulation is a continuation of the corporate planning process, initiated after the promulgation of the ANSTO Act in April 1987, which culminated in the publication of the ANSTO Corporate Plan, 1987. The Plan constitutes the basis for the development of business plans for each sector of the Organisation.

48710 (INIS-mf–11533) **ANSTO resources.** Australian Nuclear Science and Technology Organisation, Lucas Heights (Australia). 1987. 7p. Order Number DE90601777/JAW. Available from NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS.

Details of ANSTO's specialities, expertise, facilities, products and services in each of its program and support areas are given in tabular form.

48711 (KEK-PR–88-3) **Photon Factory activity report, 1988.** National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan). 1989. 405p. Order Number DE90701894/JAW. Available from NTIS (US Sales Only), PC A18/MF A01.

Since the foundation of Photon Factory a decade age, it has played an important role as a unique synchrotron X-ray radiation source in Japan. Installation of various insertion devices, storage of intense positron beam and reduction of beam emittance were the substantial achievements in the last several years. The exploitation of the TRISTAN Accumulation Ring as a synchrotron radiation source has paved the way for a new potential of development. All these activities have brought about the increase of beamlines and the expansion of scientific fronts. Third International Conference on Synchrotron Radiation Instrumentation held in Tsukuba was one of the most highlighted events for the facility. In coming years, it is intended to open new research fields using the promising single bunch beam and circularly polarized wiggler radiation. The TRISTAN Main Ring also will be applied to synchrotron radiation research. The Photon Factory in a national synchrotron radiation research facility affiliated to the National Laboratory for High Energy Physics, and it consists of a 2.5 GeV electron linac, a 2.5 GeV storage ring as a synchrotron light source, beam lines and experimental stations. The operation, improvement and development in respective departments are reported. (Kako, I.).

9902 Mathematics and Computers

Refer also to citation(s) 46815, 46888, 46928, 46931, 47006, 47073, 47077, 47104, 47113, 47124, 47153, 47156, 47157, 47164, 47167, 47243, 47244, 47245, 47270, 47295, 47324, 47382, 47418, 47453, 47455, 47472, 47716, 47723, 47729, 47753, 47758, 47766, 47770, 47771, 47848, 47857, 47925, 47954, 48170, 48280, 48283, 48288, 48314, 48317, 48537, 48575, 48579, 48662, 48702, 48708, 48748, 48750, 48751, 48754

48712 (AD-A–207190/0/XAB) **Parallel version of the Boyer-Moore prover. Technical report.** Kaufmann, M.; Wilding, M. Computational Logic, Inc., Austin, TX (USA). Feb 1989. 43p. (TR–39). Available from NTIS, PC A03/MF A01.

The idea of this system is to use idle processors to increase the speed of NQTHM. There were many design considerations, including: no shared-file system; easy-to-kill jobs on a given host; easy-to-prevent job assignment on a given host; Robust; and nicer user interface. The system will be used to process an NQTHM event list in parallel, with a given granularity. Given a granularity of n, then the first job will process the first n PROVE-LEMMAs. Each subsequent job will process n PROVE-LEMMAs. Since an arbitrary subsequence of PROVE-LEMMAs may require a previous definition, each will process all previous definitions. A subsequence of PROVE-LEMMAs may also require PROVE-LEMMAs from previous subsequences, treating each PROVE-LEMMA as an ADD-AXIOM. This system allows the user to run a job on multiple machines in parallel. The issue of machine use has been discussed at Computational Logic and a preliminary policy adopted. It is the policy at Computational Logic to allow users to run parallel jobs using the dispatcher. Spawned jobs are to be run at the default (nice) priority level, and it is OK for any user to kick spawned parallel jobs off the local machine if he wishes (without feeling bad about it).

48713 (AD-A–207318/7/XAB) **Memory-reference characteristics of multiprocessor applications under MACH.** Agarwal, A.; Gupta, A. Stanford Univ., CA (USA). Computer Systems Lab. 1988. 11p. Available from NTIS, PC A03/MF A01.

Shared-memory multiprocessors have received wide attention in recent times as a means of achieving high-performance cost effectively. Their viability requires a thorough understanding of the memory-access patterns of parallel-processing applications and operating systems. This paper reports on the memory reference behavior of several parallel applications running under the MACH operating system on a shared-memory multiprocessor. The data used for this study is derived from multiprocessor address traces obtained from an extended ATUM address-tracing scheme implemented on a 4-CPU DEC VAX 8350. The applications include parallel OPS5, logic simulation, and a VLSI wire-routing program.

48714 (AD-A–207320/3/XAB) **Parallel implementation of OPS5 on the Encore multiprocessor: Results and analysis.** Gupta, A.; Tambe, M.; Kalp, D.; Forgy, C.; Newell, A. Stanford Univ., CA (USA). Dept. of Computer Science. 1988. 24p. Available from NTIS, PC A03/MF A01.

Until now, most results reported for parallelism in production systems (rule-based systems) have been simulation results - very few real parallel implementations exist. This paper presents results from parallel implementation of OPS5 on the Encore multiprocessor. The implementation exploits very-fine-grained parallelism to achieve significant speed-ups. For one of the applications, the authors achieve 12.4 fold speed-up using 13 processes. Their implementation is also distinct from other parallel implementations in that they parallelize a highly optimized C-based implementation of OPS5. Running on uniprocessor, their C-based implementation is 10-20 times faster than the standard Lisp implementation distributed by Carnegie Mellon University. In addition to presenting the performance numbers, the paper discusses the details of the parallel implementation - the data structures used, the amount of contention observed for shared data structures, and the techniques used to reduce such contention.

48715 (AD-A–207321/1/XAB) **Suitability of message-passing computers for implementing production systems.** Gupta, A.; Tambe, M. Stanford Univ., CA (USA). Dept. of Computer Science. 1988. 6p. Available from NTIS, PC A02/MF A01.

Two important parallel architecture types are the shared-memory architectures and the message-passing architectures. In the past, researchers working on the parallel implementations of production systems have focused either on shared-memory multiprocessors or on special-purpose architectures. Message-passing computers have not been studied. The main reasons have been the large message-passing latency (as large as a few milliseconds) and high message reception overheads (several hundred microseconds) exhibited by

the first-generation message-passing computers. These overheads are too large for the parallel implementation of production systems, where it is necessary to exploit parallelism at a very fine granularity to obtain significant speed-up (subtasks execute about 100 machine instructions).

48716 (AD-A–207705/5/XAB) **Laboratory for Computer Science progress report 24, July 1986–June 1987.** Massachusetts Inst. of Tech., Cambridge, MA (USA). Lab. for Computer Science. Jun 1987. 319p. Available from NTIS, PC A14/MF A01.

The work reported here was carried out within the Laboratory for Computer Science, an MIT interdepartmental laboratory. Partial contents include: Clinical Decision Making; An Artificial Intelligence Approach to Clinical Decision Making; A Program for the Management of Heart Failure; Computation Structures; Computer Languages and Systems; Computer Applications; Distributed Computing; Bulk Data Transfer Protocol; Information Mechanics; The CAM-7 Multiprocessor; Fluid Dynamics; Texture-Locked Loops; Mercury; Parallel Processing; Computer Programming Methodology; Real Time Systems. A list of publications follows this report.

48717 (AD-A–207809/5/XAB) **Fault detection and reliability of the GASS (Geophysical Airborne Survey System) multiprocessor survey system.** Bourqeois, B.S.; Harris, M.M.; Ross, J.H.; Wischow, T.G.; Martinez, A.B. Naval Ocean Research and Development Activity, NSTL, MS (USA). Apr 1989. 9p. (NORDA-FR–89-009-351). Available from NTIS, PC A02/MF A01.

Pub. in Proceedings of the Southeastcon '89 Conference on Energy and Information Technologies in the Southeast, 319-325(9-12 Apr 1989).

The failure-detection features of the Geophysical Airborne Survey System (GASS) are investigated in this paper. An overview of the system design is given to allow discussion of the failure-detection problem in GASS. The types of data collected are ordered by their importance to the survey mission, and the types of failures that may occur are identified. The ability of the system to detect errors is analyzed for each data type, and for the communications links between major subsystems. Since GASS is an environmental survey system, model-based failure detection methods are not applicable. Recommendations are made to enhance system reliability by improving various aspects of failure detection within GASS. All major hardware in GASS is specified so all modifications suggested by this study are implementable in software or through minor hardware alterations.

48718 (AD-A–207833/5/XAB) **Programming language supporting first-class parallel environments. Technical report.** Jagannathan, S. Massachusetts Inst. of Tech., Cambridge, MA (USA). Lab. for Computer Science. Jan 1989. 210p. (MIT/LCS/TR–434). Available from NTIS, PC A10/MF A01.

This thesis presents a new programming model called the symmetric model in which the representation of programs is identical to the representation of data: to specify a computation, one defines a data structure. This data structure possesses the semantics of a first-class naming environment-it defines a scope and can be used to affect the evaluation environment of other expressions. A new programming language is presented called Symmetric Lisp, based on the symmetric model. Program structures in Symmetric Lisp are considered non-strict: a program's components may be examined even as its other elements continue to evaluate. The first part of the thesis investigates the interaction of non-strictness with first-class naming environments. The second part of the thesis discusses the compilation and implementation of Symmetric Lisp. An extended type inference system is presented for first-class environments that can be used to infer the proper evaluation environment of identifiers found within the scope of environment-yielding expressions. A translation of Symmetric Lisp into a high-level data flow language is presented.

48719 (AD-A–207877/2/XAB) **BM/C(3) algorithm mapping onto concurrent processors. Final report, May-December 1987.** Pattipati, K.R.; Luh, P.B.; Lee, R.T.; Shah, S.; Deb, S. Connecticut Univ., Storrs, CT (USA). Dept. of Environmental and Systems Engineering. Mar 1989. 98p. (UCT/DESE-TR–88-3). Available from NTIS, PC A05/MF A01.

This report is concerned with the mapping of large-scale resource-allocation algorithms onto parallel computing architectures. The mapping problem is viewed as one of assigning the nodes of a finite, directed, acylic task graph (representing the logical and data dependencies among the tasks constituting the algorithm) onto the nodes of a finite, undirected processor graph (denoting the parallel computing architecture). The objective is to minimize the completion time of the algorithm such that the redundancy, processor memory, and security constraints are satisfied. The delays introduced by task queueing, message transmission, message collision and precedence constraints are explicitly modeled. Four algorithms are presented to solve the mapping problem.

48720 (AD-P–005777/8/XAB) **High-speed parallel-processing networks for advanced architectures.** Morgan, D.R. Air Force Avionics Lab., Wright-Patterson AFB, OH (USA). Jun 1988. 17p. Available from NTIS, PC A03/MF A01.

This article is from 'Computing Systems Configuration for Highly Integrated Guidance and Control Systems.' AD-A199 308, 8.1-8.17; Availability: This paper covered by copyright. No copies furnished by DTIC/NTIS.

This paper describes various parallel-processing architecture networks that are candidates for eventual airborne use. An attempt at projecting which type of network is suitable or optimum for specific metafunction or stand-alone applications is made. However, specific algorithms will need to be developed and bench marks executed before firm conclusions can be drawn. Also, a conceptual projection of how these processors can be built in small, flyable units through the use of wafer-scale integration is offered. The use of the PAVE PILLAR system architecture to provide system level support for these tightly coupled networks is described. The author concludes that: (1) extremely high processing speeds implemented in flyable hardware is possible through parallel-processing networks if development programs are pursued; (2) dramatic speed enhancements through parallel processing requires an excellent match between the algorithm and computer-network architecture; (3) matching several high speed parallel oriented algorithms across the aircraft system to a limited set of hardware modules may be the most cost-effective approach to achieving speed enhancements; and (4) software-development tools and improved operating systems will need to be developed to support efficient parallel-processor use.

48721 (CONF-8908137–1) **Implementation of a customizable instruction editing and delivery system.** Williams, L.C.; Broadaway, E.R. Oak Ridge National Lab., TN (USA). [1989]. 5p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 5. annual conference of the Society for Applied Learning Technology on applications of artificial intelligence and CD-ROM in education and training; Arlington, VA (USA); 23-25 Aug 1989. Order Number DE89016856/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

This paper describes an instruction editing and delivery system written in Smalltalk, an object-oriented programming environment and language. The system uses a mixture of interactive video and computer graphics for training and certification of personnel. The use of Smalltalk as the implementation environment permits application-specific extensions to be made easily as well as making integration of new video delivery hardware easier. The system is well-suited for training and laboratory automation. Present applications of the system are presented. 1 ref., 3 figs.

48722 (CONF-8908137–2) **Troubleshooting complex systems–An expert system, interactive video, transportable PC solution.** Broadaway, E.R.; Williams, L.C.; Mullens, J.A.; Zabriskie, W.L.; Roberts, A.G. Oak Ridge National Lab., TN (USA). Aug 1989. 6p. Sponsored by U.S. DOE Energy Research. DOE Contract AC05-84OR21400. From 5. annual conference of the Society for Applied Learning Technology on applications of artificial intelligence and CD-ROM in education and training; Arlington, VA (USA); 23-25 Aug 1989. Order Number DE89016861/JAW. Available from NTIS, PC A02/MF A01 - OSTI; GPO Dep.

Troubleshooting complex control systems presents special problems for the maintenance technician. Because problems occur infrequently, maintenance or repair work may be requested many months after the technician received training for a particular system. An expert system with an object-oriented programming environment for authoring was developed at Oak Ridge National Laboratory to address this problem. The need to transport the delivery system to

a variety of locations necessitated the integration of a transportable, 386-based system with color display. Using Smalltalk/V286, this system combined an inference engine with a windowed environment for development of rules and tutorials and display of documentation. In addition, still-frame video with graphic overlays are used.

48723 (DOE/ER–0422) **Summaries of the FY 1989 Applied Mathematical Sciences Research program.** USDOE Office of Energy Research, Washington, DC (USA). Scientific Computing Staff. Sep 1989. 62p. Sponsored by U.S. DOE Energy Research. Order Number DE89016694/JAW. Available from NTIS, PC A05/MF A01 - OSTI; GPO Dep.

This report is a compilation of summaries of the individual research projects that constitute the Applied Mathematical Sciences research subprogram managed by the Director Scientific Computing Staff in the Office of the Director of Energy Research, US Department of Energy. Major topics covered are: analytical and numerical methods; information analysis and display; advanced computing concepts; energy sciences advanced computation; and capital equipment for national laboratories.

48724 (DOE/ER/25026–32) **Potential for parallelism in explicit linear methods.** Skeel, R.D.; Tam, Hon-Wah. Illinois Univ., Urbana, IL (USA). Dept. of Computer Science. Jul 1989. 11p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER25026. (CONF-8907106–3: Institute of Mathematics and its applications: conference on computational ordinary differential equations, London (UK), 3-7 Jul 1989). Order Number DE89017329/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Numerical methods for ordinary initial value problems that do not depend on special properties of the system are usually found in the class of linear multi-stage multi-value methods, first formulated by J.C. Butcher. Among these the explicit methods are easiest to implement. For these reasons there has been considerable research activity devoted to generating methods of this class which utilize independent function evaluations that can be performed in parallel. Each such group of concurrent function evaluations can be regarded as a stage of the method. It turns out that parallelism afford only limited opportunity for reducing the computing time with such methods. This is most evident for the simple linear homogenous constant coefficient test problem, which is essentially a matter of approximating the exponential by an algebraic function. For a given number of stages and a given number of saved values, parallelism offers a somewhat enlarged set of algebraic functions from which to choose. However there is absolutely no benefit in having the degree of parallelism (number of processors) exceed the number of saved values of the method. Thus, in particular, parallel one-step methods offer no speedup over serial one-step methods for the standard linear test problem. Because of the fairly remarkable modelling ability of the standard test problem, one should not expect much better speedups for general nonlinear problems. 8 refs.

48725 (DOE/ER/25026–33) **Generalized BDF [backward differentiation formula] methods applied to Hessenberg form DAEs.** Keiper, J.B. Illinois Univ., Urbana, IL (USA). Dept. of Computer Science. Aug 1989. 113p. Sponsored by U.S. DOE Energy Research. DOE Contract FG02-87ER25026. (UIUCDCS-R–89-1534;UILU-ENG–89-1753). Order Number DE89017328/JAW. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

We study the numerical solution of Hessenberg form differential algebraic equations by variable stepsize generalized backward difference formulae (GBDF). GBDF methods of sufficiently high order are shown to converge for problems of index two, three, or four. The proof techniques developed are not sufficiently powerful to show convergence for index five problems. In addition we perform very high precision numerical experiments on problems of index two, three, four, and five using the standard six step backward difference formula. The experiments confirm the analysis regarding the error behavior of the index two and three problems, but suggest that the analysis of the index four problem is too pessimistic. It appears from the experiments that index five problems can also be solved by GBDF methods. 12 refs., 99 figs., 12 tabs.

48726 (IPPJ-DT–150) **User's manual of self learning gas puffing system for plasma density control.** Tanahashi, S. Nagoya Univ. (Japan). Inst. of Plasma Physics. Apr 1989. 46p. (In Japanese). Order Number DE90701798/JAW. Available from NTIS (US Sales Only), PC A03/MF A01.

Pre-programmed gas puffing is often used to get adequet plasma density wave forms in the pulse operating devices for fusion experiments. This method has a defect that preset values have to be adjusted manually in accordance with changes of out gassing rate in successive shots. In order to remove this defect, a self learning system has been developed so as to keep the plasma density close to a given reference waveform. After a few succesive shots, it accomplishes self learning and is ready to keep up with a gradual change of the wall condition. This manual gives the usage of the system and the program list written in BASIC and ASSEMBLER languages. (author).

48727 (LA-UR–89-2660) **Using PATRAN: From eyeballs to submarines and more.** Fales, J.L.; Weinacht, D.J. Los Alamos National Lab., NM (USA). 1989. 18p. Sponsored by U.S. DOE Management & Administration. DOE Contract W-7405-ENG-36. (CONF-8909187–2: PATRAN users conference, Costa Mesa, CA (USA), 6-8 Sep 1989). Order Number DE89016989/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

To maintain a position at the cutting edge of state of the art engineering mechanics, an engineer must develop a reliable set of powerful working tools. In the Advanced Engineering Technology group at Los Alamos National Laboratory, we have established such a basis. Our projects have run the gamut from eyeballs to submarines and more. We use a variety of finite element codes in our analyses with PATRAN playing a central role, both as a preprocessor and as a postprocessor. This paper will emphasize a few projects that have used PATRAN, will highlight useful and disappointing aspects of PATRAN, and finally, will demonstrate the use of PATRAN as an effective communications tool. 13 figs., 1 tab.

48728 (LA-UR–89-2828) **TIKTEK: A Tektronix emulator based on 2D GMR.** Van Riper, K.A. Los Alamos National Lab., NM (USA). [1989]. 21p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. (CONF-8909186–1: 8. annual conference of the Apollo Domain User's Society, New Orleans, LA (USA), 10-13 Sep 1989). Order Number DE89016986/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Our group at Los Alamos set up an Apollo network in 1986. We have 15 monochrome DN3000s and a few DN320s. These workstations replaced Tektronix and VT640 terminals. The majority of the work in our group is to develop and maintain programs on the Laboratory CRAY computers; for most of our users, the workstations serve primarily as a fancier terminal for communicating with the CRAYs. The supercomputer codes we use and support include a number of graphics programs which are designed to talk to Tektronix terminals. We thus require a good Tektronix evaluation capability on the Apollos. This paper describes some of the internal design features of the emulator TIKTEK and places where Apollo specific features helped or hindered.

48729 (MLM–3598) **Operational measures of central tendency.** Silver, G.L. EG and G Mound Applied Technologies, Miamisburg, OH (USA). 28 Aug 1989. 27p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-88DP43495. Order Number DE89016959/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

New operational formulas can be used in place of the average for estimating the center point of data. The new formulas are often more accurate than the average on known functions and their predictive properties resemble the median. One of them is used in a new method of bivariate interpolation on four points in rectangular array. New operational formulas for estimating slopes at the endpoints of three-point curves are presented. 7 refs.

48730 (MLM-MU–89-68-0001) **A computer program for the IBM-PC/Sheffield air column interface.** Sparkman, J.P. EG and G Mound Applied Technologies, Miamisburg, OH (USA). 7 Aug 1989. 13p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-88DP43495. Order Number DE89015176/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A computer program was created to assist in the initial evaluation of the functional characteristics of several Sheffield Air-to-Electronic

Columns. This report is intended to document the commands and techniques used to gather data from the columns.

48731 (N–89-20641) **Automating the multiprocessing environment.** Arpasi, D.J. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Mar 1989. 10p. (NASA-TM–4103;E–4426;NAS–1.15:4103). Available from NTIS, PC A02/MF A01.

An approach to automate the programming and operation of tree-structured networks of multiprocessor systems is discussed. A conceptual, knowledge-based operating environment is presented, and requirements for two major technology elements are identified as follows: (1) An intelligent information translator is proposed for implementating information transfer between dissimilar hardware and software, thereby enabling independent and modular development of future systems and promoting a language-independence of codes and information; (2) A resident system activity manager, which recognizes the systems capabilities and monitors the status of all systems within the environment, is proposed for integrating dissimilar systems into effective parallel processing resources to optimally meet user needs. Finally, key computational capabilities which must be provided before the environment can be realized are identified.

48732 (N–89-20684) **Message passing kernel for the hypercluster parallel processing test bed.** Blech, R.A.; Quealy, A.; Cole, G.L. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. 1989. 10p. (NASA-TM–101952;E–4652;NAS–1.15:101952;CONF-890372–: 4. hypercube, concurrent computers and applications, Monterey, CA (USA), 6-8 Mar 1989). Available from NTIS, PC A02/MF A01.

A Message-Passing Kernel (MPK) for the Hypercluster parallel-processing test bed is described. The Hypercluster is being developed at the NASA Lewis Research Center to support investigations of parallel algorithms and architectures for computational fluid and structural mechanics applications. The Hypercluster resembles the hypercube architecture except that each node consists of multiple processors communicating through shared memory. The MPK efficiently routes information through the Hypercluster, using a message-passing protocol when necessary and faster shared-memory communication whenever possible. The MPK also interfaces all of the processors with the Hypercluster operating system (HYCLOPS), which runs on a Front-End Processor (FEP). This approach distributes many of the I/O tasks to the Hypercluster processors and eliminates the need for a separate I/O support program on the FEP.

48733 (N–89-20685) **Initial operating capability for the hypercluster parallel-processing test bed.** Cole, G.L.; Blech, R.A.; Quealy, A. National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center. Mar 1989. 10p. (NASA-TM–101953;E–4647;NAS–1.15:101953;CONF-890372–: 4. hypercube, concurrent computers and applications, Monterey, CA (USA), 6-8 Mar 1989). Available from NTIS, PC A02/MF A01.

The NASA Lewis Research Center is investigating the benefits of parallel processing to applications in computational fluid and structural mechanics. To aid this investigation, NASA Lewis is developing the Hypercluster, a multi-architecture, parallel-processing test bed. The initial operating capability (IOC) being developed for the Hypercluster is described. The IOC will provide a user with a programming/operating environment that is interactive, responsive, and easy to use. The IOC effort includes the development of the Hypercluster Operating System (HYCLOPS). HYCLOPS runs in conjunction with a vendor-supplied disk operating system on a Front-End Processor (FEP) to provide interactive, run-time operations such as program loading, execution, memory editing, and data retrieval. Run-time libraries, that augment the FEP FORTRAN libraries, are being developed to support parallel and vector processing on the Hypercluster. Special utilities are being provided to enable passage of information about application programs and their mapping to the operating system. Communications between the FEP and the Hypercluster are being handled by dedicated processors, each running a Message-Passing Kernel, (MPK). A shared-memory interface allows rapid data exchange between HYCLOPS and the communications processors. Input/output handlers are built into the HYCLOPS-MPK interface, eliminating the need for the user to supply separate I/O support programs on the FEP.

48734 (PB–89-182877/XAB) **Supercomputers, architectures and applications.** van Stijn, T.L. Ministerie van Verkeer en Waterstaat, The Hague (Netherlands). Dienst Informatieverwerking. 1988. 23p. (In Dutch). (SWA–88/102). Available from NTIS, PC EE03/MF A01.

SUPERCOMPUTERS/parallel processing; PARALLEL PROCESSING; COMPUTER ARCHITECTURE; COMPUTERS; SUPERCOMPUTERS; USES

48735 (SAND–88-1218) **An interactive program for constrained spline approximation of numerical data.** Amos, D.E. Lawrence Livermore National Lab., CA (USA). Jul 1989. 32p. Sponsored by U.S. DOE Defense Programs. DOE Contract AC04-76DP00789. Order Number DE89016674/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A portable FORTRAN program for (weighted) least squares curve fitting of data using piecewise cubic polynomials is presented. Menu options for equality and inequality constraints can be applied to produce smooth curves whose first and second derivatives match qualitative aspects of the data. Addition and deletion of knots by menu selection allows considerable flexibility. The code is distributed on a 360K- formatted diskette. A PC with a FORTRAN compiler will suffice to execute the code. 21 refs., 5 figs.

48736 (UCID–21695) **Domain decomposition for partial differential equations.** Perkins, L. Lawrence Livermore National Lab., CA (USA). 1989. 56p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE89016669/JAW. Available from NTIS, PC A04/MF A01 - OSTI.

This is a survey paper. It begins with a cursory look at partial differential equations and methods of solving them on digital computers. This includes a brief discussion of mapping complex geometric domains to simpler ones. The second chapter is a discussion about domain decomposition and it's current directions. Chapter three introduces some of the physical Fluid Dynamics problems we wish to solve. Chapters four and five are the heart of the paper. They discuss current research work in domain decomposition for elliptic and hyperbolic equations. 42 refs., 23 figs.

48737 (UCID–21768) **Scientific data manipulation using attribute constaints.** Longstaff, T.A.; Blattner, M.M.; Milton, J. Lawrence Livermore National Lab., CA (USA). Jun 1989. 30p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE89016715/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

Today's computational environment for large scientific data sets usually requires the use of a supercomputer for generating data and a wordstation for the analysis and display. Formatting and selection of post-processed scientific data for analysis and display tools requires a knowledge of a myriad of small filter tools that may reside on a distributed system. The selection of filter tools for reformatting is confusing to applications users and programmers alike. In this article we describe a model of data, data attributes, tool specifications, and constraints upon all of these. A constraint-based system is then described that allows the user to enter data requirements enabling a series of tool configurations (a path) to perform the desired reformatting, which we believe provides a much more understandable and usable paradigm for both application users and programmers. 14 refs., 2 figs.

48738 **Parallelism in rule-based systems.** Sabharwal, A. (Dept. of Electrical Engineering and Computer Science, Louisiana State Univ., Baton Rouge, LA (US)); Iyengar, S.S.; DeSaussure, G.; Weisbin, C.R. vp of Applications of artificial intelligence VI. Trivedi, M.M. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (1988). (CONF-880464–: Applications of artificial intelligence VI, Orlando, FL (USA), 4-6 Apr 1988).

Rule-based systems, which have proven to be extremely useful for several Artificial Intelligence and Expert Systems applications, currently face severe limitations due to the slow speed of their execution. To achieve the desired speed-up, this paper addresses the problem of parallelization of production systems and explores the various architectural and algorithmic possibilities. The inherent sources of parallelism in the production system structure are analyzed and the trade-offs, limitations and feasibility of exploitation of these sources of parallelism are presented. Based on this analysis,

the authors propose a dedicated, coarse-grained, n-ary tree multiprocessor architecture for the parallel implementation of rule-based systems and then present algorithms for partitioning of rules in this architecture.

48739 **Design and implementation of a parallel computer for expert system applications.** Butler, P.L. (Instrumentation and Controls Div., Oak Ridge National Lab., Oak Ridge, TN (US)); Allen, J.D. Jr.; Bouldin, D.W. vp of Applications of artificial intelligence VI. Trivedi, M.M. SPIE Society of Photo-Optical Instrumentation Engineers, Bellingham, WA (1988). (CONF-880464–: Applications of artificial intelligence VI, Orlando, FL (USA), 4-6 Apr 1988).

A parallel computer for high-speed execution of expert system programs has been designed and implemented at the Oak Ridge National Laboratory. Programs written in the popular OPS5 language for serial machines need not be modified by the programmer, since the compiler on this special-purpose machine automatically employs the parallelism inherent in the language. Tasks are automatically distributed to parallel rule processors which can evaluate OPS5rules in parallel. Performance improvements of a factor of 10 over serial machines have already been demonstrated. Enhancements are under way to attain a performance improvement of 100 or more over serial machines for artificial intelligence applications requiring the evaluation of thousands of rules each recognize-act cycle. The initial hardware implementation of the parallel architecture consists of a host computer that broadcasts to 64 parallel rule processors over a transmit-only bus. The communication time is to a minimum by using direct-memory access and a memory-mapped addressing scheme that permit each of the parallel rule processors to receive the appropriate information simultaneously. A wired-OR completion flag signals the host whenever all of the parallel rule processors have finished their recognition Tasks. The host then extracts information from those rule processors whose rules have been satisfied and, based on a global criterion, selects one of these rules. The host then carries out the actions dictated by this rule and broadcasts new information to the rule processors to begin another recognize-act cycle.

9903 Information Handling

Refer also to citation(s) 47106, 47278, 48114, 48115, 48116, 48675

48740 (DOE/ER–0423) **FEDIX: An on-line information service for universities and other research organizations: User's guide, Version 2.0, Release 1.** USDOE Office of Energy Research, Washington, DC (USA). Oct 1989. 45p. Sponsored by U.S. DOE Energy Research. Order Number DE89016695/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report in a guide describing the use of FEDIX. FEDIX is a system of on-line databases providing information on Federal Government programs of interest to colleges and universities. The system currently contains information on the Department of Energy's energy-related equipment program, DOE research and development programs, faculty/student education programs, and DOE's minority assistance programs. DOE's sub-system is referred to as "DOEINFO." Databases containing information on Office of Naval Research and National Aeronautics and Space Administration programs will be developed in the fall of 1989 and will be available on-line in FY 1990. It is anticipated that other government agencies will soon be providing information on their programs.

48741 (DOE/OSTI–4500-Rev.75) **Program distribution for unclassified scientific and technical reports: Instructions and category scope notes: Revision 75.** Simpson, W.F. Jr.; Amburn, D. (eds.). USDOE Office of Scientific and Technical Information, Oak Ridge, TN (USA). Aug 1989. 108p. Sponsored by U.S. DOE Management & Administration. Order Number DE89005395/JAW. Available from NTIS, PC A06/MF A01 - OSTI; GPO Dep.

The DOE Office of Scientific and Technical Information (OSTI) in conjunction with DOE Program Offices establishes distribution categories for research, development, and technological reports emanating from DOE programs. The revised category numbers and scope notes contained in this publication were coordinated between OSTI and DOE Program Offices with input from DOE Field Offices. Decisions regarding whether reports will be distributed are made by Program Offices in conjunction with DOE Field Offices and OSTI. This revision of DOE/OSTI-4500 contains the revised distribution category numbers and scope notes along with the printed copy requirement, which shows the number of copies required to make program distribution.

48742 (EGG-M–89040) **Reporting environmental data of known quality.** Pink, P.N.; Jessup, J.S.; Knight, D.K. EG and G Idaho, Inc., Idaho Falls, ID (USA). [1989]. 15p. Sponsored by U.S. DOE Nuclear Energy. DOE Contract AC07-76ID01570. (CONF-8907123–2: EPA waste testing and quality assurance symposium, Washington, DC (USA), 24-28 Jul 1989). Order Number DE89016214/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

A comprehensive approach was developed for environmental program documents to integrate sampling, analytical chemical, quality control, and historical data when reporting results to accommodate technical and programmatic data users. The objective of this paper is to present this comprehensive and effective means of reporting the quality and usability of the analytical chemical data generated from the analysis of environmental samples. Most environmental programs require legally admissable data of known quality that will satisfy regulatory requirements and the rigors of potential litigation. Analytical chemical data generated using validated Environmental Protection Agency (EPA) protocols or their equivalent provide the supporting quality control (QC) information necessary to assess the quality of the data; however, no conclusion is drawn as to the programmatic usability of the data. The approach outlined in this paper details a mechanism for assessing, documenting, and reporting what is known about the data quality and consequently the usability of the analytical chemical data generated. 2 refs., 3 tabs.

48743 (IPPJ-DT–151) **Atomic and molecular database for fusion.** Ogasawara, R. (ed.) (National Lab. for High Energy Physics, Tsukuba, Ibaraki (Japan)). Nagoya Univ. (Japan). Inst. of Plasma Physics. Apr 1989. 56p. (In Japanese). Order Number DE90701799/JAW. Available from NTIS (US Sales Only), PC A04/MF A01.

Workshop on 'Atomic and Molecular Database for Fusion' was held at the Institute of Plasma Physics on 20th January 1989 under a callaborating research program of Research Information Center at the Institute of Plasma Physics, Nagoya University. This joint program aims to construct a database which is easy to manipulate for plasma physicist. The database will consists of the evaluated data for rata coefficients for various collisional processes. (author).

48744 (JAERI-M–89-054) **Database for the degraded core coolability experiments.** Maruyama, Yu; Abe, Yutaka; Soda, Kunihisa; Mino, Yoshitaka. Japan Atomic Energy Research Inst., Tokyo (Japan). May 1989. 148p. (In Japanese). Order Number DE90701751/JAW. Available from NTIS (US Sales Only), PC A07/MF A01.

During a severe accident of a light water reactor, as was observed in the TMI-2 accident, a debris bed which consists of particulate debris would be formed in the core region and/or lower head region. There exsits potential for the debris remelting followed by the accident propagation into the containment vessel, in the worst case to the environment, when the adequate cooling is not maintained, because of continuation of decay heat release from the debris. The quantified estimation of the coolability of the debris bed is recognized as an important item with respect to severe accident sequence analyses and accident management analyses. Many organizations including JAERI have been performing the experimental studies on the debris coolability together with analytical research. However it is difficult to specify the configuration of the debris bed since the process of severe accident sequence would be complex, as the result, the debris bed formed during the severe accident would show various configurations. Therefore the experiments in order to clarify the debris bed coolability are conducting to cover the wide range of experimental conditions, considering the configurations of debris beds and coolant flow conditions, and other parameters. The experimental database was developed at JAERI for debris coolability for the aim of effective usage of the experimental results to future experimental plans and analytical studies. This report summarizes the overview of the database, operation procedures and applications. (author).

48745 (JINR-E-2-88-363, pp. 61-67) **Organization of DELPHI experimental data analysis. DELPHI interactive graphics centre at JINR.** Tsyganov, E.N.; Vodop'yanov, A.S. Joint Inst. for Nuclear Research, Dubna (USSR). 1988. (CONF-8712145--: 3. seminar on physics of e^+e^- interactions, Dubna (USSR), 8-9 Dec 1987). In *Proceedings of the seminar Physics of e^+e^- interactions.* Order Number DE89018001/JAW. Available from NTIS (US Sales Only), PC A06/MF A01 - OSTI; INIS.

The philosophy of the DELPI off-line interactive centre at CERN is presented briefly. The main purpose of this centre is to provide a fast turn-around and graphics support for the express analysis line. It should comprise 2 medium power computers of VAX type, 2-3 emulators 2-3 high resolution graphics facilities and 2-3 personal computers. The processing of the events at the DELPHI interactive centre will include the following steps: full processing of a small sample of events, futher reduction of this samples by physics analysis programs, detailed scanning and correction of the reduced sample, physics analysis of the sample of events. The DELPHI off-line software is considered. 20 refs; 4 figs.

48746 (ORNL/TM-11142) **The external design phase of the breeding and multigeneration support system: A tracking and decision support system for NCTR [National Center for Toxicological Research].** Strand, R.; Cox, T.L.; Sjoreen, A.; Alvic, D. Oak Ridge National Lab., TN (USA). May 1989. 490p. Sponsored by U.S. Department of Health and Human Services. DOE Contract AC05-84OR21400. Order Number DE89015673/JAW. Available from NTIS, PC A21/MF A01 - OSTI; GPO Dep.

The National Center for Toxicological Research (NCTR) is the basic research arm of the US Food and Drug Administration (FDA). The NCTR has upgraded and standardized its computer operations on Digital Equipment Corporation VAX minicomputers using Software AG's ADABAS data base management system for all research applications. The NCTR is currently performing a large study to improve the functionality of the animal husbandry systems and applications called Breeding/Multigeneration Support System (BMSS). When functional, it will operate on VAX equipment using the ADABAS data base management system, TDMS, and COBOL. Oak Ridge National Laboratory (ORNL) is supporting NCTR in the design, prototyping, and software engineering of the BMSS. This document summarizes the external design elements that include data entry screens, screen reports, summary and status reports, and functional definitions of screen and report data. ORNL will provide research support to NCTR in the additional phases of systems life cycle development for BMSS. ORNL has prepared this document according to NCTR's Standard Operating Procedures for Systems Development. 8 figs., 7 tabs.

48747 (ORNL/TM-11215) **The internal design phase of the breeding and multigeneration support system: A tracking and decision support system for NCTR [National Center for Toxicological Research].** Strand, R.; Cox, T.L.; Sjoreen, A.; Alvic, D. Oak Ridge National Lab., TN (USA). Jun 1989. 400p. Sponsored by U.S. Department of Health and Human Services. DOE Contract AC05-84OR21400. Order Number DE89016933/JAW. Available from NTIS, PC A17/MF A01 - OSTI; GPO Dep.

The National Center for Toxicological Research (NCTR) is the basic research arm of the US Food and Drug Administration (FDA). The NCTR has upgraded and standardized its computer operations on Digital Equipment Corporation VAX minicomputers using Software AG's ADABAS data base management system for all research applications. The NCTR is currently performing a large study to improve the functionality of the animal husbandry systems and applications called Breeding/Multigeneration Support System (BMSS). When functional, it will operate on VAX equipment using the ADABAS data base management system, TDMS, and COBOL. Oak Ridge National Laboratory (ORNL) is supporting NCTR in the design, prototyping, and software engineering of the BMSS. This document summarizes the internal design elements that include data structures, file structures, and system attributes that were required to facilitate the decision support requirements defined in the external design work. Prototype pseudocode then was developed for the recommended system attributes and file and data structures. Finally, ORNL described the processing requirements including the initial access of the BMSS, integration of the existing INLIFE system and the STUDY DEFINITION system under development, data system initialization and maintenance, and BMSS testing and verification. This document describes ORNL's recommendations for the internal design of the BMSS. ORNL will provide research support to NCTR in the additional phases of systems life cycle development for BMSS. ORNL has prepared this document according to NCTR's Standard Operating Procedures for Systems Development. 6 figs., 5 tabs.

48748 (UCID-21679) **CALS [Computer-aided Acquisition and Logistic Support Test Network information exchange: User's manual.** Lawrence Livermore National Lab., CA (USA). 12 Jun 1989. 18p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CTN-89-007). Order Number DE89016700/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The DoD Computer-aided Acquisition and Logistic Support (CALS) Test Network is conducting tests of the military standard for the Automated Interchange of Technical Information (MIL-STD-1840A) and its companion suite of military specifications. The CTN is a DoD- sponsored confederation of voluntary participants from industry and government, managed jointly by a technical staff at Air Force Logistics Command (AFLC) and Lawrence Livermore National Laboratory (LLNL). The objective of CTN tests is to demonstrate and evaluate the interchange and functional use of digital data information between industry and government using the CALS standards. The CTN Information Exchange (CTN Info-X) is a combination of information services for participants and sponsors of the work of the CALS Test Network. This manual tells how to access and use the CALS Info-X.

48749 (UCID-21680) **DSREDS/EDCARS MIL-STD-1840A review.** Lawrence Livermore National Lab., CA (USA); West Coast Information System, Walnut Creek, CA (USA). 15 Aug 1989. 16p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CTN-89-005). Order Number DE89016699/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

This report presents a review of the Oklahoma City Air Logistics Center (OC-ALC) EDCARS system to determine the technical feasibility and options available for DSREDS/EDCARS Systems to support the interchange of raster based technical information in accordance with MIL-STD-1840A and MIL-R-28002 type I. The import capability supports receipt of ANSI labeled tapes in accordance with MIL-STD-1840A and conversion of the MIL-R-28002 format (standard CCITT Group 4 compressed files) to DSREDS/EDCARS compatible files (Wraparound compressed files). Results of the review indicate that interchange and import of technical information in accordance with MIL-STD-1840A and MIL-R-28002 can be economically accomplished utilizing one of three basic options: implementation of MIL-STD-1840A and CCITT Group 4/Wraparound programs on the EDCARS mainframe; implementation of MIL-STD-1840A and CCITT Group 4/Wraparound conversion platform connected to the EDCARS mainframe; and implementation of a MIL-STD-1840A and EDCARS Tape Import/Export conversion platform. Implementation estimates for the labor associated with the three options range from four to six engineer-months. Some of the options have additional hardware costs as described in section 6.

48750 (UCID-21765) **Publishing systems structured Test No. 1: Summary report.** Lawrence Livermore National Lab., CA (USA); SYSCON Corp., San Diego, CA (USA). 10 Aug 1989. 59p. Sponsored by U.S. Department of Defense. DOE Contract W-7405-ENG-48. (CTN-89-013). Order Number DE89016683/JAW. Available from NTIS, PC A04/MF A01 - OSTI; GPO Dep.

The DOD Computer-aided Acquisition and Logistic Support (CALS) Test Network (CTN) is conducting tests of the military standard for the Automated Interchange of Technical Information (MIL-STD-1840A) and its companion suite of military specifications. The CTN is a DOD- sponsored confederation of voluntary participants from industry and government, managed jointly by a technical staff at Air Force Logistics Command (AFLC) and Lawrence Livermore National Laboratory (LLNL). The objective of CTN tests is to demonstrate and evaluate the interchange and functional use of digital technical information between industry and government using the CALS standards.

9905 Civilian Defense

Refer also to citation(s) 47319

48751 (AD-A-207449/0/XAB) **SDS (Space Defense System) software measurement requirements. Technical report, 5 December 1988-6 April 1989.** Analytic Sciences Corp., Arlington, VA (USA). 6 Apr 1989. 98p. (TASC-TR-9033-1). Available from NTIS, PC A05/MF A01.

This report addresses the criteria for evaluation of SDS software and measurement requirements by identifying the standards and attributes required for SDS software products and the software-development process. The identification of measurement requirements for SDS software was performed in three phases. The first phase was a review of standards and development process relevant to SDS, as they pertained to software metrics. The second phase was a detailed examination of SDS software characteristics, definition of software domains, and quality and productivity-measurement requirements. The third phase integrated the measurement requirements identified previously into a methodology for the application of software metrics.

48752 (LA-11572-MS) **Comparison of laser and neutral particle beam discrimination.** Canavan, G.H. Los Alamos National Lab., NM (USA). Sep 1989. 16p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-36. Order Number DE89017786/JAW. Available from NTIS, PC A03/MF A01 - OSTI; GPO Dep.

The relative ability of lasers and neutral particle beams (NPBs) to discriminate reentry vehicle (RV) and anti-satellite (ASAT) decoys is pivotal in assessing their relative worth as strategic defenses. This report evaluates their ability and assesses their relative contributions, concluding that NPBs can typically discriminate about 100 times as many objects as can lasers, and do so with significantly greater certainty. 7 refs., 2 figs.

48753 (PB-89-196661/XAB) **Strategic Defense Initiative, 1989. Report to the Congress.** Strategic Defense Initiative Organization, Washington, DC (USA). 13 Mar 1989. 358p. Available from NTIS, PC A16/MF A01.

See also AD-A203576.

This report serves as a summary of the SDI legacy of President Reagan, who launched the initiative with his historic speech of March 23, 1983. The report describes in detail current assessment of the best program for resolution of remaining technical issues, validation of technologies, and demonstration of our ability to integrate them. The program of research, development, and testing would, if adequately funded, support a fully informed decision by the President and Congress in the future on whether to deploy a strategic defense of the United States. Such defenses could enhance deterrence and increase stability.

48754 (UCID-21722) **Instructions for using SOW Pk program.** Magnoli, D.E. Lawrence Livermore National Lab., CA (USA). Jun 1989. 12p. Sponsored by U.S. DOE Defense Programs. DOE Contract W-7405-ENG-48. Order Number DE89016668/JAW. Available from NTIS, PC A03/MF A01 - OSTI.

PKSOW is a Fortran program developed at Lawrence Livermore National Laboratory to calculate the probability of kill (P_k) of a submarine-launched ASW nuclear standoff weapon. The calculation can be done for a broad spectrum of conditions: the user specifies weapon characteristics (yield, depth of burst), target localization and course and speed errors, target evasion tactics, target damage specifications, and safe standoff parameters. Output from the program includes a table of Pk at various standoff ranges for each of several yields. This version of PKSOW has been adapted to run on the IBM PC using MS/DOS. The output from the program may be used with MS CHART to produce plots of Pk vs standoff range.

Corporate Author Index

This index lists the corporate authors responsible for issuing the documents in this publication which are identified primarily by report number. The corporate names are entered in standardized forms as defined in *DOE Energy Data Base: Corporate Author Entries* (DOE/TIC-4585). Each entry under a corporate name includes the document title and citation number. Three items of information may appear in parentheses: (1) an abbreviation to identify the document type, such as a report; (2) the country of publication, also abbreviated; and (3) the language of the document if non-English (R;US;In French). Author affiliations are not listed in this index.

A

Advanced Fuel Research, Inc., East Hartford, CT (USA)
A study of depolymerization and crosslinking reactions in coal liquefaction: Final report, 14:46820 (R;US)

Aerodyn-Energiesysteme, Damendorf (Germany, F.R.)
Measurements on the AEOLUS 11 wind power plant and comparison with rated loads, 14:47069 (R;DE;In German)

Aerospace Corp., El Segundo, CA (USA). Chemistry and Physics Lab.
Chemical effects of Ne(+) bombardment on the MoS_2(0001) surface studied by high-resolution photoelectron spectroscopy. Technical report, 14:48495 (R;US)

Aerospace Corp., El Segundo, CA (USA). Space Sciences Lab.
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Possible discontinuity in octupole behaviour in the Pt-Hg region, 14:48455 (R;AU)
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Test fast kicker pulser, 14:47802 (R;US)
The application of synchrotron radiation to microprobe trace element analysis of biological samples, 14:47461 (R;US)
The Brookhaven accelerator test facility injection system, 14:47799 (R;US)
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Preparation of radioactive labelled compounds Pt.1. ^{82}Br labelled organic bromine compounds, 14:47545 (R;FR;In French)
Preparation of radioactive labelled compounds. Pt. 2. ^{82}Br labelled organic bromine compounds by isotopic exchange, 14:47546 (R;FR;In French)
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Summaries of the FY 1989 Applied Mathematical Sciences Research program, 14:48723 (R;US)

USDOE Office of Inspector General, Washington, DC (USA). Capital Regional Office
Audit of the use of annual appropriations to fund contracts, 14:47210 (R;US)

USDOE Office of Scientific and Technical Information, Oak Ridge, TN (USA)
Program distribution for unclassified scientific and technical reports: Instructions and category scope notes: Revision 75, 14:48741 (R;US)
Summaries of FY 1989 research in the chemical sciences, 14:47238 (R;US)

USDOE Pittsburgh Energy Technology Center, PA (USA)
[Pittsburgh Energy Technology Center] quarterly technical progress report for the period ending June 30, 1988, 14:46791 (R;US)

USDOE Richland Operations Office, WA (USA)
Application for approval for construction of the Fueled Clad Fabrication System, the Radioisotope Power Systems Facility, and the Fuel Assembly Area, 14:46929 (R;US)

Supplemental information for a notice of construction for the Fueled Clad Fabrication System, the Radioisotope Power Systems Facility, and the Fuel Assembly Area, 14:46985 (R;US)

V

Valtion Teknillinen Tutkimuskeskus, Espoo (Finland)
Continuum-mechanical derivation of the conservation equations for the pyrolysis and combustion of wood. Research report, 14:47029 (R;FI)
Energy consumption of single-family houses. Partly storing electrical heating, 14:47276 (R;FI;In Finnish)
Methods for municipal traffic safety work - improvement of traffic environment. A literature survey, 14:47280 (R;FI;In Finnish)
Outdoor air intake in dwellings equipped with mechanical exhaust ventilation, 14:47277 (R;FI;In Finnish)
Real time measurement of combustion aerosol size distributions, 14:47778 (R;FI;In Finnish)
Updraft gasification of waste fuels, 14:47020 (R;FI;In Finnish)

Valtion Teknillinen Tutkimuskeskus, Jyvaeskylae (Finland). Kotimaisten Polttoaineiden Lab.
Experiments on the combustion of small peat particles in an entrained-flow, isothermal furnace. Research note, 14:46883 (R;FI)

Versuchsgrubengesellschaft m.b.H., Dortmund (Germany, F.R.)
Fires in workings with different dips, and consequences to be drawn for the ventilation systems. Final report, 14:46886 (R;DE;In German)

Virginia Electric and Power Co., Richmond, VA (USA)
Evaluation of burnup credit for dry storage casks, 14:46966 (R;US)

Virginia Polytechnic Inst. and State Univ., Blacksburg, VA (USA)
Study of the stress wave factor technique for evaluation of composite materials. Final report, 14:47440 (R;US)

Virginia Univ., Charlottesville, VA (USA). Div. of Urban and Environmental Planning
Federalism and the surface-water program. Technical report, 14:48059 (R;US)

W

Walker Geobotanical Surveys, Lafayette, CO (USA)
Wetland soils and vegetation, Arctic Foothills, Alaska, 14:47973 (R;US)

Washington Univ., Seattle, WA (USA)
Correlation between x-ray flux and rotational acceleration in Vela X-1. Final technical report, 14:48187 (R;US)
Giant nuclear resonances, 14:48465 (R;US)
Nonlinear resonance: Annual report, 14:47742 (R;US)

Washington Univ., Seattle, WA (USA). Dept. of Applied Mathematics
Analytical and numerical studies in flow development: Progress report, 1 July 1988 to Present, 14:48284 (R;US)

Washington Univ., Seattle, WA (USA). Dept. of Civil Engineering
Pilot-scale HCl control by dry alkaline injection for emissions from refuse incinerators. Technical report, 14:47946 (R;US)

Washington Univ., Seattle, WA (USA). Dept. of Physics
Eoet-Wash constraints on multiple Yukawa interactions and on a coupling to "isospin", 14:48437 (R;US)
High-sensitivity hillside results from the Eoet-Wash experiment, 14:47823 (R;US)
X-ray and γ-ray spectroscopy of solids under pressure: Annual technical progress report, October 1988–October 1989, 14:47471 (R;US)

Washington Univ., Seattle, WA (USA). Nuclear Physics Lab.
Beam diagnostics for the University of Washington superconducting booster, 14:47806 (R;US)
Nuclear Physics Laboratory, University of Washington annual report, 1989, 14:48430 (R;US)
The University of Washington polarized ion source, 14:47805 (R;US)

Welding Consultants, Inc., Columbus, OH (USA)
The Meta-Lax method of stress reduction in welds: First quarterly report, 14:47349 (R;US)

West Coast Information System, Walnut Creek, CA (USA)
DSREDS/EDCARS MIL-STD-1840A review, 14:48749 (R;US)

West Virginia Univ., Morgantown, WV (USA). Dept. of Mechanical and Aerospace Engineering
Computational fluid dynamics assessment: Volume 1, Computer simulations of the METC [Morgantown Energy Technology Center] entrained-flow gasifier: Final report, 14:46815 (R;US)

Westfaelische Berggewerkschaftskasse, Bochum (Germany, F.R.). Pruefstelle fuer Grubenbewetterung
Fires in workings with different dips, and consequences to be drawn for the ventilation systems. Final report, 14:46886 (R;DE;In German)

Westinghouse Hanford Co., Richland, WA (USA)
Physics support analyses for full central-zone flux flattening for full-power (3000- to 4000-MW) operation, 14:47113 (R;US)
Xenon transient simulation for N Reactor, 14:47124 (R;US)

Westinghouse Hanford Co., Shippingport, PA (USA)
Contaminated concrete scabbling at the Shippingport Station Decommissioning Project, 14:47000 (R;US)

Westinghouse Savannah River Co., Aiken, SC (USA)
Automated data collection (ADC) extension of a generic computerized nuclear material accountability system, 14:47006 (R;US)
Computerized procedure for preparation of secondary standards, 14:47472 (R;US)

Wisconsin Univ., Madison, WI (USA)
[Thermodynamics, kinetics, and interfare morphologies of phase formation reactions between metals and gallium arsenide: Bulk vs thin-film studies],"14:47420 (R;US)

Wisconsin Univ., Madison, WI (USA). Dept. of Electrical and Computer Engineering
Fusion plasma theory: Task 3, Auxiliary heating in tokamaks: Progress report, [1988–1989], 14:48585 (R;US)
High power microwave transmission systems for electron cyclotron resonance plasma heating: Volume IV, Progress report, September 1, 1988–August 31, 1989, 14:48672 (R;US)

Wisconsin Univ., Madison, WI (USA). Inst. for Environmental Studies
Critique of several regulatory analyses regarding solvent wastes. Technical report, 14:48000 (R;US)
Response of the US EPA (Environmental Protection Agency) region 5 states to the nonpoint source reporting requirements of the 1987 Clean Water Act amendments. Technical report, 14:48056 (R;US)
Water-pollution abatement expenditures in the Wisconsin paper industry. Technical report, 14:48037 (R;US)

Wyoming Univ., Laramie, WY (USA)
Static tensile and tensile creep testing of five ceramic fibers at elevated temperatures, 14:47397 (R;US)
Strain energy release rate as a function of temperature and preloading history utilizing the edge delamination fatique test method. Contractor resepor, July 1986-October 1988, 14:47441 (R;US)

Y

Yale Univ., New Haven, CT (USA). School of Forestry and Environmental Studies
Combined sewer overflow: A management study. Technical report, 14:48061 (R;US)

Personal Author Index

Authors' surnames are indexed in the form appearing in the publication cited; given names generally have been reduced to initials. For documents with multiple authors, each author name is indexed. The entry for a primary author (first author listed on an abstracted document) includes the full document title and citation number. Entries for other authors provide a cross-reference to the primary author. Also included is information on the document type, country of publication, and the document language listed in parentheses in the format (J;FR;In French and English). Accent marks are not input because of computer alphabetization. Spelling and transliteration follow standard conventions.

See Shimizu, H., 14:48295

A

Abashina, A.V., *See* Kazdaev, Kh.R., 14:47362
Abazov, A.I., *See* Gavrin, V.N., 14:48318
Abdalla, E., SL(2,R) current algebra in two dimensional conformal quantum gravity, 14:48540 (R;XA)
Abdalla, M.C.B., *See* Abdalla, E., 14:48540
Abdel-Gayed, R.G., The straining of premixed turbulent flames, 14:47602 (BA;US)
Abdurashitov, D.N., *See* Gavrin, V.N., 14:48318
Abe, D.K., *See* Cutting, J.L., 14:47768
Abe, Hitoshi, *See* Nishio, Gunji, 14:46931
Abe, Yutaka, *See* Maruyama, Yu, 14:48744
Abercrombie, J.S., ORNL (Oak Ridge National Laboratory) implementation of New Health and safety requirements (DOE (Department of Energy) Order 5480.11), 14:46987 (RA;US)
Aborina, I.N., *See* Polyakov, A.A., 14:47093
Abramowicz, H., Overview of νN and ν-barN interactions, 14:48310 (RA;PL)
Abt, R., High-temperature superconductors: physical properties of single crystalline- and polycrystalline samples, and of thin films, 14:47423 (RA;AT;In German)
Ackerbauer, P., Experimental investigations on muon-catalyzed nuclear fusion, 14:48673 (RA;AT;In German)
Measurement of sticking probability in muon-catalysed fusion, 14:48678 (RA;AT;In German)
Adams, C.L., *See* Billingsley, J.P., 14:47853
Adams, D.F., *See* Zimmerman, R.S., 14:47397, 14:47441
Adams, L.M., *See* Criminale, W.O., 14:48284
Adams, R.C., Baghouse efficiency on a multiple-hearth incinerator burning sewage sludge, 14:47950 (R;US)
Adamus, P.R., Wetlands and water quality: EPA's (Environmental Protection Agency's) research and monitoring implementation plan for the years 1989-1994, 14:48062 (R;US)
Adati, K., *See* Toi, K., 14:48650
Adelberger, E.G., High-sensitivity hillside results from the Eoet-Wash experiment, 14:47823 (R;US)
Adibi, M.M., On estimation of uncertainties in analog measurements, 14:47716 (R;US)
Adler, J., Recent results on hadronic D_s and D meson decays from the Mark III, 14:48321 (R;US)
Aerne, E.T., *See* Zwicky, H.U., 14:47478
Afanas'ev, M.L., *See* Zeer, Eh.P., 14:47525
Afonin, M.A., Spectroscopic studies of cesium, strontium, and cerium (3) ion complexing with cobalt chlorinated dicarbollide (CCD) and hexapolyethylene glycol (HPEG) in nitrobenzene, 14:47517 (RA;SU;In Russian)
See Slavetskaya, A.I., 14:47505
Agarwal, A., Memory-reference characteristics of multiprocessor applications under MACH, 14:48713 (R;US)
Agarwal, P.K., Mass transfer processes around burning char particles in fluidized beds, 14:46870 (BA;US)
Agashov, I.A., *See* Antonov, P.G., 14:47514
Agnelli-Monti, M., *See* Poier, E., 14:48125
Agogino, K.L., *See* Dery, V.A., 14:46948
Ahern, B.S., Static periodic field device for free-electron laser, 14:47750 (P;US)
Ahlstedt, H., Modelling of confined swirling flows, 14:47777 (R;FI)
Ahmed, S.A., *See* Wakeman, B.H., 14:46966
Ahn, B., Estimation of ionospheric electrodynamic parameters using ionospheric conductance deduced from bremsstrahlung x-ray image data. Technical report, 14:48234 (R;US)
Aichholzer, K., *See* Abt, R., 14:47423
Aiginger, H., *See* Schachner, J., 14:48103
Aiken, R.J., *See* Hoopes, B.L., 14:46993
Aissa, M., *See* Young, J.O., 14:47954
Akau, R.L., *See* Russo, A.J., 14:47382
Akchulakov, M.T., *See* Kazdaev, Kh.R., 14:47362
Akhmin, S.M., ENDOR spectroscopy of admixture ions in crystals of inorganic chlorides, 14:47486 (RA;SU;In Russian)
Akhtar, K.M., Neutronic analysis of a reference LEU core for Pakistan research reactor using oxide fuel, 14:47120 (R;PK)
See Younus, M., 14:47117
Akhtar, T., Influence of storage on fungal infestation in spices, 14:48128 (R;PK)
Akiyama, R. and others, *See* Toi, K., 14:48650
Albrecht, A., Evolution of cosmic string networks, 14:48218 (R;US)
Albrecht, R., *See* Plasil, F., 14:48458
See Young, G.R., 14:48444
Albrecht, R.W., Xenon transient simulation for N Reactor, 14:47124 (R;US)
Alcon, R.R., *See* Sheffield, S.A., 14:48519
Aldis, D.F., Model calculations and experimental measurements of the response of HMX porous beds to deflagration and shock, 14:47865 (R;US)
See Urtiew, P.A., 14:47864
Aldissi, Mahmoud, *See* Armes, S.P., 14:47430
Aleksandrov, K.A., *See* Ljadov, G.D., 14:47090
Alerhand, O.L., Vibrational properties of the π-bonded chain model of the Si(111) 2 x 1 surface, 14:48279 (BA;US)
Alexander, C., *See* Burson, S.B., 14:47164
Alexander, R.E., The Three Mile Island Unit 2 accident and its impact on the NRC, 14:47186 (J;US)
Alexandreas, D.E., *See* Haines, T.J., 14:48183
Alfano, R.R., *See* Petricevic, V., 14:47745
Allan, D.C., *See* Alerhand, O.L., 14:48279
Allegrini, I., *See* Hering, S.V., 14:47937
Allen, D.F., Evaluation of commercially available radionuclide assay equipment suitable for solid LLW characterization/certification, 14:46936 (RA;US)
Allen, J.D. Jr., *See* Butler, P.L., 14:48739
Allen, L.J., Statistical regularization applied to the analysis of e-He scattering data, 14:48250 (R;AU)
Allen, P.B., Calculations of resistivity and superconducting T_c in transition metals, 14:48536 (BA;US)
See Broughton, J.Q., 14:47452
Allen, R.C., *See* Haines, T.J., 14:48183
Allen, T.J., The canonical structure of the manifestly supersymmetric string, 14:48384 (J;US)
Allendorf, M.D., *See* Tully, F.P., 14:47638
Allison, J.M., *See* Mitchell, D.H., 14:46982
Almaguer, D., *See* Richardson, F.D., 14:47944
Altenkirch, R.A., Opposed-flow flame spread and extinction in mixed-convection boundary layers, 14:47668 (BA;US)

See Mackowski, D.W., 14:47647
Alvar, K.R., SNRS [stationary neutron radiography system] component positioning systems, 14:47730 (J;US)
Alvic, D., *See* Strand, R., 14:48746, 14:48747
Amagishi, Y., Observation of m = +- 1 MHD surface waves and shear Alfven waves converted from surface waves, 14:48642 (RA;AU)
Amann, T., Utilization of small wind energy converters in the Federal Republic of Germany. Final report, 14:47070 (R;DE;In German)
Amano, Hikaru, *See* Moriuchi, Shigeru, 14:47961
Amano, T., *See* Ida, K., 14:48648
See Nagata, A., 14:48651
Ambach, W., Vertical distribution of the Chernobyl fallout in snow profiles, 14:47992 (RA;AT;In German)
Ambo, Noriaki, Concept design of Advanced Marine Reactor (1), core design. Design study for optimized core, 14:47102 (R;JP;In Japanese)
Ambrosiano, J., An electromagnetic finite element particle code on an unstructured grid, 14:48662 (R;US)
See Rambo, P.W., 14:48663
Ambrosiano, J.J., *See* Nielsen, D.E. Jr., 14:48578
Amburn, D., *See* Simpson, W.F. Jr., 14:48741
Amos, D.E., An interactive program for constrained spline approximation of numerical data, 14:48735 (R;US)
Amsbaugh, J.F., *See* Weitkamp, W.G., 14:47806
Anane-Fenin, K., Distribution and seasonal variations of diffuse fraction, 14:47918 (R;XA)
Anderson, D., *See* Stefanski, R., 14:47784
Anderson, D.N., Origin of density enhancements in the winter polar-cap ionosphere, 14:48233 (R;US)
Anderson, G.D., Relationship between large-hole drilling rates and compressive strength of NTS rock types, 14:47896 (RA;US)
See Kusubov, A.S., 14:47885
Anderson, J.L., Experience of TSTA milestone runs with 100 grams-level of tritium, 14:47166 (J;US)
See Ashibe, K., 14:48702
See Yamanishi, T., 14:48700
Anderson, M.A., Selection and design of remedial action for the high priority sites at the Rocky Flats Plant, 14:46991 (RA;US)
Anderson, M.P., Microstructural dynamic study of grain growth, 14:48537 (BA;US)
Anderson, T.A., *See* Walton, B.T., 14:48143
Ando, M., Report of the plan meeting on use of synchrotron radiation from the Tristan Main Ring, 14:47817 (R;JP;In Japanese)
Andre, W.L., Substation evaluation using Diagnostic Logic System (DIALOG), 14:47081 (R;US)
Andreeva, S.G., Crystal structure and spectroscopic properties of tetraphenylarsonium tetrachlorouranylate, 14:47550 (RA;SU;In Russian)
Aneke, S.J., *See* Chidume, C.E., 14:48549
Anosov, O.L., *See* Gavrin, V.N., 14:48318
Ansari, S.A., Development of on-line reactivity meter for PARR, 14:47112 (R;PK)
On-line testing of PARR instrumentation by plant computer, 14:47121 (R;PK)
Anspaugh, B.E., Characterization of production GaAs solar cells for space, 14:47032 (R;US)
Antinone, R., HPM [high power microwave] testing of electronic components, 14:47841 (R;US)
Antolak, A.J., *See* Ozturk, N., 14:48529
See Pontau, A.E., 14:47480
Antoniewicz, P.R., Improved Kohn-Sham exchange potential, 14:47344 (RA;US)
Antonov, P.G., Application of moessbauer (^{119}Sn) and optical spectroscopy to study bimetallic platinum metal complexes with tin, 14:47514 (RA;SU;In Russian)
Aparo, M., REIMIEP 1987: an interlaboratory U-235 enrichment determination by gamma measurement on solid UF6 sample, 14:46927 (R;IT)
App, F.N., *See* Krier, D., 14:47893
Appelbaum, J., Restrictive loads powered by separate or by common electrical sources, 14:47044 (R;US)
See Singer, S., 14:47043
Appelman, E.H., Oxygen-17 NMR of seven-valent neptunium in aqueous solution, 14:47556 (J;US)
Appleton, B.R., Ion beam processes in advanced electronic materials and device technology, 14:47449 (B;US)
Aprigiano, L.F., Nickel oxide, ceramic-insulated, high-temperature coating, 14:47407 (P;US)
Arbuzov, V.L., Annealing of radiation defects in region of 3 stage in nickel and in nickel-titanium alloy, 14:47361 (RA;SU;In Russian)
Aref-Azar, H., *See* Wallner, G., 14:47473
Arenz, R.W., A miniature inexpensive oxygen sensing element: Quarterly review, 14:47843 (R;US)
Arian-Schad, K., *See* Poier, E., 14:48125
Arko, A.J., A fermi liquid electric structure and the nature of the carriers in high-T_c cuprates: A photoemission study, 14:48531 (R;US)
Armes, S.P., Non-aqueous polypyrrole colloids: Synthesis and characterization, 14:47430 (R;US)
Armstrong, E.S., *See* Naraghi, M.H.N., 14:47754
Armstrong, R.C., Hydrodynamic and reactive/diffusive instabilities in a dynamic model of liquid propellant combustion, 14:47697 (BA;US)
Arnold, J.A., *See* Biederman, R.T., 14:47318
Arpasi, D.J., Automating the multiprocessing environment, 14:48731 (R;US)
Arthur, E.D., *See* Wilson, W.B., 14:48474
Arthur, M.F., Laboratory studies to support microbially mediated in situ soil remediation, 14:47978 (RA;US)
Arthur, R.C., Application of the quasi-stationary state approximation to interpret water-rock interactions in open hydrothermal systems, 14:46981 (R;US)
Predicted reaction paths during the hydrothermal alteration of Columbia River basalt: A sensitivity analysis of variability in the composition of the mesostasis, 14:46960 (RA;US)
Asato, Katsuo, Effects of curvature on extinction of premixed flames stabilized in stagnation flow, 14:47670 (BA;US)
Ashibe, K., Code development for analysis of TSTA compound cryopumps, 14:48702 (J;US)
Ashida, H., *See* Nagata, A., 14:48651
Aslanov, L.A., *See* Sujsalu, A., 14:47500
Assink, R.A., Density profiles of a draining foam by nuclear magnetic resonance imaging, 14:46897 (J;US)
Ast, D.G., *See* Kalejs, J.P., 14:47456
Atallah, S., Water-spray barriers for LNG (liquefied natural gas) vapor mitigation. Topical report, September 1987-November 1988, 14:46911 (R;US)
Athey, G.F., *See* Sjoreen, A.L., 14:47156
Atkin, S.D., *See* Tabor, M.A., 14:48704
Atkins, A.S., *See* Davis, A.J., 14:46812
Atkinson, A., Environmental impact of fusion power, 14:48698 (J;GB)
Attela, J.L., *See* Schaefer, B.E., 14:48230
Atwood, J.L., *See* Evans, W.J., 14:47531
Atwood, W.B., B identification by topology with the SLD Detector, 14:48320 (R;US)
Auerbach, S.I., [Agricultural countermeasures following an accidental release of radionuclides]: Foreign trip report, June 11–22, 1989, 14:48049 (R;US)
Augustson, R.H., Role of IAEA [International Atomic Energy Agency] safeguards in confidence building, 14:47247 (R;US)
Austin, W.E., Disassembly and defueling of the TMI-2 [Three Mile Island Unit 2] reactor vessel lower core support assembly, 14:47189 (J;US)
See McGough, M.S., 14:47193, 14:47731
Auxier, J.A., Dosimetry studies pertaining to the accident at TMI-2 [Three Mile Island Unit 2], 14:47179 (J;US)
Avedisian, C.T., *See* Yang, J.C., 14:47711
Avva, V.S., Effect of thermal and cyclic loads on silicon carbide yarn reinforced glass matrix composites: Final report, August 15, 1984–February 14, 1988, 14:47419 (R;US)
Awes, T.C., Report on the Oak Ridge workshop on Monte Carlo codes for relativistic heavy-ion collisions, 14:48485 (J;NL)
[Proton-nucleus collisions]: Foreign trip report, April 11, 1988–June 11, 1988, 14:48319 (R;US)
[The first WA80 production run with ^{16}O nuclei at ultrarelativistic energies]: Foreign trip report, November 4, 1986–December 11, 1986, 14:47796 (R;US)
See Plasil, F., 14:48458
See Young, G.R., 14:48444

Axelbaum, R.L., Preferential diffusion and concentration modification in sooting counterflow diffusion flames, 14:47569 (BA;US)
See Du, D.X., 14:47570
Axler, K.M., High-temperature materials compatibility testing of refractory crucible materials: TaC, Y_2O_3, Y_2O_3-coated MgO, and BN, 14:46930 (R;US)
Axness, C.L., Mechanisms leading to single event upset, 14:47821 (R;US)
Aziz, M.J., Effect of pressure on self diffusion in crystalline silicon, 14:47458 (BA;US)

B

Baacke, J., Present status of the bag model - a cursory review, 14:48399 (RA;PL)
Babaev, V.P., Atomic displacement distribu< on during ion irradiation, 14:48512 (RA;SU;In Russian)
Babapour, R., *See* Reed, N.R., 14:48150
Babcock, S.R., *See* Schneider, L.X., 14:48690
Babu, K.S., Dirac neutrino masses as two-loop radiative corrections, 14:48358 (J;US)
Babushkina, T.A., *See* Dudareva, A.G., 14:47515
Bach, B., Transferreactions at thermonuclear energies, 14:48677 (RA;AT;In German)
Badger, P.C., *See* Wright, L.L., 14:47030
Badurek, G., Measurement of Berry's topological phase for noncyclic evolution, 14:48566 (RA;AT;In German)
Search for crystal-catalyzed fusion reactions, 14:48674 (RA;AT;In German)
Baek, N.H., *See* Jaffe, P.R., 14:48030
Baetz, P., Detailed kinetic studies on elementary NH_2-reactions, 14:47639 (BA;US)
Baez-Martinez, J., Best demonstrated available technology (BDAT) background document for K103 and K104. Final report, 14:47290 (R;US)
Best demonstrated available technology (BDAT) background document for K046 nonreactive subcategory. Final report, 14:47291 (R;US)
Best demonstrated available technology (BDAT) background document for K101 and K102: Low arsenic subcategory. Final report, 14:47292 (R;US)
Bai, Z., *See* Adler, J., 14:48321
Bailey, J.K., Waste certification at the Y-12 Plant, 14:46938 (RA;US)
Bailey, T.L., *See* DuCharme, A.R., 14:47088
Bair, R.A., *See* Dunning, T.H. Jr., 14:47262
Bakac, A., Preparation, properties, and crystal structure of a novel series of macrocyclic organocobalt complexes, 14:47533 (J;US)
Unusually rapid homolysis of the cobalt-carbon bond in a macrocyclic benzylcobalt complex, 14:47532 (J;US)
See Ram, M.S., 14:47023
Baktash, C., [Nuclear structure physics]: Foreign trip report, May 9–June 14, 1988, 14:48478 (R;US)
See Plasil, F., 14:48458
See Young, G.R., 14:48444
Baldo, P.M., *See* King, W.E., 14:47384
See Rehn, L.E., 14:48497
Ballaux, C., *See* Regge, P. de, 14:47477
Balles, E.N., *See* Rao, A.K., 14:47313
Ballico, M.F., Alfven wave heating in the TORTUS tokamak, 14:48640 (RA;AU)
Ballico, M.J., Fast Alfven eigenmodes in the TORTUS tokamak, 14:48635 (RA;AU)
See Bowden, M.D., 14:48616
Balog, J., Hidden local symmetries from flavour anomalies of QCD, 14:48398 (RA;PL)
Balsley, D.R., *See* Gossett, C.A., 14:47805
Ban, Tatsuya, *See* Asato, Katsuo, 14:47670
Banerjee, S., Numerical simulation of a natural circulation decay heat removal experiment conducted at ETEC: Final report, 14:47100 (R;US)
Banks, B.A., Simulation of the low earth orbital atomic oxygen interaction with materials by means of an oxygen ion beam, 14:47439 (R;US)
Banks, H.T., Numerical studies of identification in nonlinear distributed parameter systems. Final report, 14:48574 (R;US)
Bansal, N.P., Crystallization kinetics of BaO-Al_2O_3-SiO_2 glasses, 14:47396 (R;US)
Baral, S., Cadmium sulfide mediated photoelectric effects in bilayer lipid membranes, 14:47540 (J;US)
Barat, C., *See* Schaefer, B.E., 14:48230
Barbella, R., Spray-swirl interaction and early pyrolysis of kerosene and light oils spray flames produced by simplex pressure atomizer, 14:47707 (BA;US)
Bardin, D.Yu., On the process e^+e^-->$Z^0\nu\nu$-bar near the Z^0 threshold, 14:48350 (RA;SU)
Barger, V., Spin correlation effects in the hadroproduction and decay of very heavy top quark pairs, 14:48360 (J;US)
Barhen, J., *See* Iyengar, S.S., 14:47295
Baria, R., *See* Willis-Richards, J., 14:47053, 14:47055
Bark, R.A., *See* Dracoulis, G.D., 14:48453, 14:48456
Barker, F.C., *See* Vermeer, W.J., 14:48439
Barlow, N.G., Cratering record in the inner solar system: Implications for earth, 14:48191 (RA;US)
Barlow, P.M., *See* Tang, R.T., 14:47967
Barr, D.W., Geologic containment of radioactive waste, 14:46969 (R;US)
Barr, W.L., *See* Devoto, R.S., 14:48693
Barrett, W.M., *See* Taylor, J.S., 14:48038
Barry, J., *See* Welch, K.M., 14:47801
Barsotti, D.A., Drinking-Water Criteria Document for polychlorinated biphenyls (PCBs) (final), April 1988, 14:48067 (R;US)
Bart, G., *See* Zwicky, H.U., 14:47478
Barteau, M.A., *See* Davis, J.L., 14:47528
Bartels, M., The reactions of benzyl radicals with hydrogen atoms, oxygen atoms, and molecular oxygen using EI/REMPI mass spectrometry, 14:47632 (BA;US)
Bartke, J., Size of the particle emission region in relativistic nuclear collisions from two-particle interferometry, 14:48472 (RA;PL)
Bartlett, R.J., *See* Arko, A.J., 14:48531
Bartlit, J.R., *See* Anderson, J.L., 14:47166
See Yamanishi, T., 14:48700
Barut, A.O., $E=(h/2\pi)\omega$, 14:48547 (R;XA)
Electron-positron system at short distances, 14:48395 (R;XA)
Excited states of zitterbewegung, 14:48560 (R;XA)
Prediction of new tightly bound-states of $H_2^+(d_2^+)$ and "cold fusion"-experiments, 14:48259 (R;XA)
Spin forces in hadron spectroscopy: quark model versus electromagnetic spin interactions, 14:48333 (RA;PL)
Bass, I.L., Ti-sapphire laser performance above 15 watts cw with line-narrowing, 14:47748 (R;US)
Bassetto, A., Critical questions concerning light cone formulation and possible renormalization of Yang-Mills theories, 14:48396 (RA;PL)
Bassham, E.A., *See* Scotto, M.V., 14:46866
Bastin, E., Experimental and computational investigation of the structure of a sooting C_2H_2-O_2-Ar flame, 14:47562 (BA;US)
Basu, S., *See* MacKenzie, E., 14:48232
Battiston, R., W^{+-} and Z^0 production in UA2 and tests of the standard model, 14:48300 (RA;PL)
Batyunya, B.V., Characteristics of hadron production in e^+e^- annihilation at LEP energy in the frame of the Luna Monte Carlo fragmentation model, 14:48354 (RA;SU)
Bauer, F., *See* Reed, R.P., 14:47444
Bauer, H.F., *See* Ryan, T.W. III, 14:46826
Bauer, J.D., *See* Cudworth, J.A., 14:46997
Bauer, P., Stopping power of water vapor for deuterium ions, 14:48264 (RA;AT;In German)
Bauer, R.G., Contaminated concrete scabbling at the Shippingport Station Decommissioning Project, 14:47000 (R;US)
Baughcum, S.L., *See* Wantuck, P.J., 14:47627
Baum, J.W., Overview, what is ALARA, 14:47158 (BA;US)
Bauman, W.J., Target acquisition methodology enhancement (TAME). Final report, March 1988-March 1989, 14:47868 (R;US)
Baumann, N., UCI mobile neutrino experiment, 14:48304 (RA;PL)
Bawagan, A.A, *See* Grisogono, A.M., 14:48254
Bawagan, A.O., *See* Frost, L., 14:48252
Baxter, A.M., *See* Burnett, S.M., 14:48451

See Dracoulis, G.D., 14:48453, 14:48456
See Spear, R.H., 14:48449
Baxter, D.J., Breakdown of chromium oxide scales in sulfur-containing environments at elevated temperatures, 14:47385 (J;US)
Baxter, P.M., *See* Lee, S.Y., 14:46974
Bayadilov, E.M., *See* Kazdaev, Kh.R., 14:47362
Bayard, S., *See* Sonich-Mullin, C., 14:48064
Bayer, S.G., Sampling and evaluating airborne asbestos dust: Course 582, 1988, 14:47938 (R;US)
Bayless, R.A., *See* Jahn, R.K., 14:47307
Bayne, C.K., [Implementation of radiometry quality-control methods for the Safeguards Analytical Laboratory at Seibersdorf, Austria]: Foreign trip report, October 3–21, 1988, 14:47833 (R;US)
See Maskarinec, M.P., 14:48029
Bean, R.M., *See* Pyne, J.W., 14:46804
Beaulac, T.P., *See* Allen, P.B., 14:48536
Beauprie, R., *See* Dunlop, J.A., 14:47555
Becher, P.F., [Technologies for future industries]: Foreign trip report, March 18–31, 1988, 14:47398 (R;US)
Beck, D.F., *See* Berman, M., 14:47152
Beckert, W.F., *See* Stanley, J.S., 14:47479
Beckmann, P., *See* Plasil, F., 14:48458
Beckstead, M.W., *See* Bizot, A., 14:47699
Bedford, D., Nonlocal character of the Rastall model, 14:48420 (J;US)
Bedick, R.C., Proceedings of the sixth annual coal-fueled heat engines and gas stream cleanup systems contractors review meeting, 14:46879 (R;US)
Beeman, J., *See* Silver, E., 14:47850
Beene, J.R., Excitation and decay of giant multipole resonances in intermediate energy heavy ion reactions, 14:48457 (R;US)
Beer, J.M., Stationary combustion: The environmental leitmotiv, 14:46846 (BA;US)
See Kang, S.G., 14:46865
See Kang, S.W., 14:46856
See Walsh, P.M., 14:46867
Begemann-Blaich, M.L., *See* Namboodiri, M.N., 14:48460
Behling, U.H., The role of radiation instruments in the recovery of TMI-2 [Three Mile Island Unit 2], 14:47184 (J;US)
Beier, E., Pyrite decomposition and structural alteration of hard coal due to microbe-assisted pyrite removal, 14:46813 (RA;US)
Bell, G.E., [International symposium on fusion nuclear technology, Tokyo, Japan, April 10, 1988]: Foreign trip report, 14:48688 (R;US)
Bell, J.M., *See* Alexander, R.E., 14:47186
Belousov, E.A., *See* Slavetskaya, A.I., 14:47505
Beltran, K., *See* Reed, N.R., 14:48150
Belyaeva, V.K., *See* Kalinichenko, N.B., 14:47495
Belytschko, T., Fission-fusion adaptivity in finite elements for nonlinear dynamics of shells. Annual technical report, 1 October 1987-30 September 1988, 14:48461 (R;US)
Bend', N.G., *See* Kobets, L.V., 14:47551
Benjamin, N.M.P., Use of electrostatic probes in R.F. plasmas for materials processing, 14:48622 (RA;AU)
Beno, M.A., *See* Williams, J.M., 14:47347
Benson, S.A., *See* McCollor, D.P., 14:46849
Benson, S.M., *See* Persoff, P., 14:46894
Bentley, J., [Electron-beam induced spectroscopies at very high spatial resolution]: Foreign trip report, April 26–March 12, 1988, 14:47847 (R;US)
Beretta, F., *See* Barbella, R., 14:47707
Berg, Fires in workings with different dips, and consequences to be drawn for the ventilation systems. Final report, 14:46886 (R;DE;In German)
Berg, R.M.,., *See* DuCharme, A.R., 14:47088
Berger, F., *See* Plasil, F., 14:48458
Bergman, C., *See* Mason, R.J., 14:47201
Bergmann, W.R., *See* Fessler, R.G., 14:46992
Bergshoeff, E., Stress-tensor commutators and Schwinger terms in singleton theories, 14:48392 (R;XA)
Berley, D., *See* Haines, T.J., 14:48183
Berman, M., Steam explosion triggering and propagation: Hypotheses and evidence, 14:47152 (R;US)
Berman, R., *See* Perkins, E.H., 14:48170
Bern, Z., Absence of wavefunction renormalization in Polyakov amplitudes, 14:48424 (J;NL)
Bernert, J., *See* Vong, R., 14:47936
Bernhardt, J.R., *See* Slagle, I.R., 14:47625
Bernstein, I.M., *See* Walston, W.S., 14:47381
Bernstein, J.S., *See* Cool, T.A., 14:47462
Berrington, K.A., *See* Fon, W.C., 14:48258
Berry, G.F., *See* Chang, S.L., 14:47078
Berry, W.B.N., *See* Wilde, P., 14:48214
Bertram, W.K., Localised co-interchange instabilities in a rotamak plasma, 14:48627 (RA;AU)
Bertrand, F.E., [Coulomb excitation with fast high Z ions: Gamma-gamma coincidence study of the IVGQR and the two-phonon giant resonance states in ^{208}Pb]: Foreign trip report, April 14–19, 1989, 14:48459 (R;US)
See Beene, J.R., 14:48457
Bertsch, K., *See* Lang, H., 14:47269
Besson, G., New large rotamak experiment at Flinders university, 14:48607 (RA;AU)
Best, P.E., *See* Solomon, P.R., 14:46863
Bestman, A.R., Unsteady hydromagnetic flow of a radiating gas in a vertical channel with axial temperature variation, 14:48286 (R;XA)
Bettinger, D., Electron spin resonance of radiation-induced defects in calcite, 14:47428 (RA;AT;In German)
Beyeler, W., Design of a disposal cell for uranium mill tailings at Collin's Ranch, Oregon: A case study in informal dynamic optimization, 14:46947 (RA;US)
Bezlepko, Eh.V., *See* Tomilova, L.G., 14:47504
Bhat, P.K., *See* Chatham, H., 14:47041
Bice, B., *See* Yamada, T., 14:47919
Biederman, R.T., Dedicated low-pressure natural gas-fueled vehicle baseline assessment. Task 3 topical report on light-duty vehicles. Topical report, January 1987-January 1989, 14:47318 (R;US)
Biefeld, R.M., *See* Jones, E.D., 14:47447
Bierlein, J.D., *See* Eddy, M.M., 14:47529
Bierley, D.A., Alternate concentration limits for the UMTRA (Uranium Mill Tailings Remedial Action) Project, 14:46998 (RA;US)
Biernacki, J.V., *See* Davis, J.M. Jr., 14:47006
Biffin, M., *See* Morgan, D., 14:46859
Bigbee, W.L., *See* Jensen, R.H., 14:48094
Bikchantaev, I.G., *See* Galimov, R.M., 14:47487
Bilenky, M.S., *See* Bardin, D.Yu., 14:48350
Bilenky, S.M., On production of supersymmetric Majorana particles in polarized e^+e^- collisions, 14:48337 (RA;PL)
Bilger, R.W., The structure of turbulent nonpremixed flames, 14:47576 (BA;US)
See Mansour, M.S., 14:47600
Billaux, D., An algorithm for mesh simplification applied to fracture hydrology, 14:48163 (J;US)
Biller, S., *See* Haines, T.J., 14:48183
Billings, C., *See* Matanoski, G., 14:47956
Billingsley, J.P., Application of crystal-lattice disintegration criteria to compute minimum shock-induced reactive conditions in solid explosives and inert materials. Final technical report, August 1987-August 1988, 14:47853 (R;US)
Bimson, S.J., *See* Taylor, P.H., 14:47656
Binder, M.J., Energy forecasting and analysis system for the US Army Materiel Command. Final report, 14:47248 (R;US)
Binder, W., *See* Schmidt, W., 14:47808
Bionta, R.M., Experimental limits on the nucleon lifetime from the Irvine -Michigan - Brookhaven (IMB) detector, 14:48307 (RA;PL)
Birch, A.D., Lift-off heights in underexpanded natural gas jet flames, 14:47613 (BA;US)
Birch, R., *See* Peaple, L.H.J., 14:47820
Bish, D.L., *See* Bolivar, S.L., 14:46970
Bishop, A.R., Phonons and charge-transfer excitations in HTS superconductors, 14:48532 (R;US)
Bittner, J., *See* Meier, U., 14:47467
Bitz, C.M., *See* Gossett, C.A., 14:47805
Bizot, A., A model for double base propellant combustion, 14:47699 (BA;US)
Blackwell, B.D., Effect of symmetry breaking errors on the H-1 plasma configuration, 14:48614 (RA;AU)
See Conway, G.D., 14:48593, 14:48612

See Shi, X.H., 14:48626
See Tou, T.Y., 14:48682
Blaich, T., *See* Namboodiri, M.N., 14:48460
Blakeley, W.F., *See* Walden, T.L., 14:48119
Blanford, K.M., GRI (Gas Research Institute) baseline projection methodology and assumptions. Topical report. Revised, 14:47249 (R;US)
See Dalbeck, B.W., 14:47250
Blanke, J.A., Internal monitoring system for radioactive waste disposal - 1988 conclusions, 14:46956 (RA;US)
Blanpain, P., Non-destructive burnup determination: Experimental investigation on low burnup gadolinia fuel, 14:47089 (RA;XA)
Blanpied, G., *See* Frascaria, R., 14:48348
Blaser, P., Development of a wind energy system for generating electrical energy in developing countries in the power range from 5 to 8 kW. Final report, 14:47071 (R;DE;In German)
Blattner, M.M., *See* Longstaff, T.A., 14:48737
Blaylock, B.G., [Training workshop on radiological dose assessment]: Foreign trip report, December 3–8, 1988, 14:48134 (R;US)
[Workshop on the Biospheric Model Validation Study (BIOMOVS)]: Foreign trip report, November 7–11, 1988, 14:47929 (R;US)
Blaylock, G.T., *See* Adler, J., 14:48321
Blazek, C.F., *See* Biederman, R.T., 14:47318
Blazek, M., Leading particle effect at higher energies, 14:48336 (RA;PL)
Blech, R.A., Message passing kernel for the hypercluster parallel processing test bed, 14:48732 (R;US)
See Cole, G.L., 14:48733
Bledsoe, J.L., *See* Voorhees, L.D., 14:46999
Bleuse, J., Investigations of the quantum photovoltaic effect in InAs-GaSb semiconductor superlattices, 14:47413 (R;US)
Blewitt, G., *See* Bionta, R.M., 14:48307
Bley, U., Primary products of the reaction between $O(^3P)$-atoms and C_2H_4 studied with ESR- and LMR-detection, 14:47537 (BA;US)
Bliem, C.J., Irreversibility reduction of low-temperature, combustion heat sources, 14:47285 (R;US)
Blint, R.J., Flammability limits for exhaust gas diluted flames, 14:47673 (BA;US)
See Haworth, D.C., 14:47588
Block, O.U.J., Correlation between radwaste processing and hazardous waste treatment processes, 14:46954 (RA;US)
Blount, C.E., Solar-powered alkali metal vapor lasers. Final report, 1 August 1986-31 October 1988, 14:47747 (R;US)
Blumthaler, M., *See* Ambach, W., 14:47992
Blyholder, G.D., Semiempirical molecular orbital modeling of catalytic reactions including promoter effects, 14:47346 (RA;US)
Bobkov, A.F., *See* Babaev, V.P., 14:48512
Boccio, J.L., *See* Hall, R.E., 14:47163
Bock, R., *See* Plasil, F., 14:48458
Bockhorn, H., Finite chemical reaction rate and local equilibrium effects in turbulent hydrogen-air diffusion flames, 14:47594 (BA;US)
See Wieschnowsky, U., 14:47565
Boden, R., *See* Regge, P. de, 14:47477
Boehm, G., *See* Kenk, G., 14:48142
Boehm, H., The influence of pressure and temperature on soot formation in premixed flames, 14:47572 (BA;US)
Boehm, M., *See* Hoffmann, G., 14:47548
Boehm, R.F., Research needs in direct-contact heat exchange, 14:47757 (BA;US)
Boehm, T.L., *See* Young, J.O., 14:47954
Boettner, J.C., *See* Chakir, A., 14:47617
Boguslavskij, A.A., ^{79,81}Br NQR study of the compounds in the system $CsBr\text{-}ZnBr_2$, 14:47513 (RA;SU;In Russian)
^{81}Br, ^{127}I NQR study of $AgBrO_3$, $AgIO_3$, Ag_2HgI_4, 14:47501 (RA;SU;In Russian)
See Kirilenko, V.V., 14:47512
Boguslavskij, L.A., ^{79,81}Br, ^{127}I NQR study of Tl-containing inorganic compounds, 14:47502 (RA;SU;In Russian)
Bohm, A., Possible evidence for supersymmetry in hadron spectra, 14:48332 (RA;PL)
Bohme, G., *See* Loesser, G. D., 14:48703
Boivin, M., *See* Frascaria, R., 14:48348
Bokhari, I.H., *See* Akhtar, K.M., 14:47120
Bolander, M.A., RELAP5/MOD2.5 thermal hydraulic analysis for an alternate fuel desig in the N Reactor, 14:47135 (R;US)
Bolinsky, J., *See* Van Hoesen, S.D., 14:46945, 14:46973
Bolivar, S.L., Mineralogy-petrology studies and natural barriers at Yucca Mountain, Nevada, 14:46970 (R;US)
Bolton, T., *See* Adler, J., 14:48321
Bonanno, R.E., *See* Bass, I.L., 14:47748
Bonk, D.L., *See* Ho, J., 14:48020
Bonner, B.E., *See* Love, W.A., 14:47839
Bonte, PH., *See* Rocchia, R., 14:48206
Bonville, P., ^{170}Yb Moessbauer study of the heavy-electron pnictides YbP, YbAs and YbSb, 14:47332 (R;FR)
Bonvin, E., Double prompt photon production at high transverse momentum by π^- on protons at 280 GeV/c, 14:48292 (R;US)
Bopp, R., *See* Bonvin, E., 14:48292
Borghese, A., Development of hot nitrogen kernel, produced by a very fast spark discharge, 14:47304 (BA;US)
Borghi, R., *See* Saied, R., 14:47586
Borisov, A.A., Promoted high-temperature reactions, 14:47620 (BA;US)
Borisov, G.V., Possibility of studying the vertex $W\gamma W$ in the process $e^+e^- \to \gamma\nu\nu$-bar, 14:48349 (RA;SU)
Borisova, L.V., Study of rhenium oxohalide coplex interaction with dithiol, 14:47511 (RA;SU;In Russian)
Bos, P., Microbial desulfurization of coal: A feasible process?, 14:46811 (RA;US)
Bose, A.C., Pulverized coal combustion: Fuel nitrogen mechanisms in the rich post-flame, 14:46873 (BA;US)
Boslough, M.B., *See* Dodson, B.W., 14:47725
Bostick, W.D., Treatment and disposal options for a heavy metals waste containing soluble Technetium-99, 14:46968 (R;US)
Boswell, R.W., Recent advances in plasma processing, 14:48598 (RA;AU)
See Cui, C.S., 14:48638
See Perry, A.J., 14:48505, 14:48606
See Vender, D., 14:48599
See Zhu, P., 14:48605
Bott, S.G., *See* Evans, W.J., 14:47531
Botts, J.A., Toxicity Reduction Evaluation protocol for municipal waste-water treatment plants. Report for 1 February-30 September 1988, 14:48045 (R;US)
Boucher, B., Magnetic order and magnetic behavior of the polished amorphous eutectic alloys $Tb_{65}Cu_{35}$ and $Er_{69.5}Cu_{30.5}$ - influence of a magnetic field, 14:47334 (R;FR)
Boudh-hir, M.E., Structure properties of confined systems. Hard spheres between ideal walls, 14:48500 (R;XA)
Boudjema, F., The electric dipole moment of the W boson and the radiation amplitude zero: [Revised], 14:48325 (R;US)
Boudreaux, J., *See* Pavelek, M.D. II, 14:47191
Bouhafid, A., On the flame structure at the base of a pool fire, 14:47650 (BA;US)
Boukhalfa, A., Time scales of the scalar field in turbulent premixed conical flames, 14:47605 (BA;US)
Bouldin, D.W., *See* Butler, P.L., 14:48739
Boundy, W.S., Jupiter Torus as a plasma and electromagnetic waveguide, 14:48180 (RA;AU)
Bouniol, P.E., Preliminary results of the immobilization of highly-salt-ladened concentrate in cement-based grout: A joint DOE/CEA (Department of Energy/Commissariat a l'Energie Atomique) research effort, 14:47223 (RA;US)
Bour-Moskalenko, Z.O., Complexone application to sample preparation for an x-ray fluorescence analysis, 14:47475 (RA;SU;In Russian)
Bourcier, W.L., Improvements in the solid solution modeling capabilities of EQ3/6, 14:48168 (RA;US)
See Glassley, W.E., 14:48169
Bourienne, F., *See* Poinsot, T., 14:47657
Bourqeois, B.S., Fault detection and reliability of the GASS (Geophysical Airborne Survey System) multiprocessor survey system, 14:48717 (R;US)
Bovet, E., *See* Frascaria, R., 14:48348
Bowden, M.D., Submillimetre laser scattering from TORTUS, 14:48616 (RA;AU)
Bowers, J., *See* Watson, J., 14:46919

Bowers, T.S., Development and application of stable isotope mass transfer reaction path models, 14:47058 (RA;US)
Bowman, C.T., *See* Lewis, G.S., 14:47580
Bowman, J.M., *See* Dunning, T.H. Jr., 14:47262
Boy, E., *See* Lang, H., 14:47269
See Schreiber, E., 14:47268
Boynton, P.E., *See* Deeter, J.E., 14:48187
Boynton, W.V., *See* Hildebrand, A.R., 14:48198
Bozoian, M., *See* Wilson, W.B., 14:48474
Bozorgi, F.L., *See* Pavelek, M.D. II, 14:47191
Brabbs, T.A., Fuel-rich catalytic combustion of Jet-A fuel-equivalence ratios 5.0 to 8.0, 14:46903 (R;US)
Bradbury, P., Development of a low-level radioactive waste disposal facility to serve the Central Interstate Compact, 14:46943 (RA;US)
Bradley, D., Burning rates in turbulent fine dust-air explosions, 14:47693 (BA;US)
See Abdel-Gayed, R.G., 14:47602
See Burson, S.B., 14:47164
Bradley, R.A., *See* Judkins, R.R., 14:46829
Brady, J.A., *See* Rutledge, S.K., 14:47033
Braithwaite, J.W., Sodium/sulfur battery studies at SNL [Sandia National Laboratories], 14:47207 (R;US)
Branagan, P.T., *See* Lorenz, J.C., 14:46896
Brand, G.F., Gyrotron IV - a new tunable gyrotron for plasma diagnostics, 14:48621 (RA;AU)
Scattering from Alfven waves using a gyrotron, 14:48637 (RA;AU)
Brand, M., The influence of the pricing of networked energy carriers on the efficient use of energy in Hesse. Final report, 14:47255 (R;DE;In German)
Brandes, S.D., *See* Graff, R.A., 14:46817
Brase, J.M., *See* Pontau, A.E., 14:47480
Braswell, J.W., *See* Botts, J.A., 14:48045
Bratton, C.B. and others, *See* Bionta, R.M., 14:48307
Brauer, F.P., Measurement methods for low-level ^{129}I determinations, 14:46979 (R;US)
Braun, C.L., Photoexcited charge pair escape and recombination: Progress report, August 1, 1988–August 1, 1989, 14:47539 (R;US)
Braun, D.G., *See* Bass, I.L., 14:47748
Braun-Unkhoff, M., A shock tube study on the thermal decomposition of toluene and of the phenyl radical at high temperatures, 14:47633 (BA;US)
Bray, K.N.C., Mean reaction rates in premixed turbulent flames, 14:47606 (BA;US)
See Cant, R.S., 14:47609
Breber, P.R., *See* Lucas, D., 14:47684
Breckenridge, C.R., *See* Quigley, D.R., 14:46803
Breitmeier, J., *See* Hasbrouck, R.T., 14:47769
Brennan, M.H., Magnetic confinement - status and prospects, 14:48615 (RA;AU)
Brenner, L.M., *See* Swindle, D.W. Jr., 14:47322
Breunlich, W.H., *See* Ackerbauer, P., 14:48673, 14:48678
Brezinsky, K., *See* Lovell, A.B., 14:47634
Brient, J.C., *See* Adler, J., 14:48321
Brik, A.B., *See* Derskij, L.S., 14:48511
Brion, C.E., *See* Frost, L., 14:48252
See Grisogono, A.M., 14:48254
Britt, H.C., *See* Namboodiri, M.N., 14:48460
Broadaway, E.R., Troubleshooting complex systems–An expert system, interactive video, transportable PC solution, 14:48722 (R;US)
See Williams, L.C., 14:48721
Broadwell, J.E., Molecular mixing and chemical reactions in turbulent shear layers, 14:47587 (BA;US)
Brockmann, J., *See* Burson, S.B., 14:47164
Brodsky, S.J., *See* Telegdi, V.L., 14:48419
Brooks, G., Estimating air-toxics emission from coal and oil combustion sources. Final report, 14:47953 (R;US)
Brooks, J.N., Erosion/redeposition analysis of the ITER [International Tokamak Engineering Reactor] divertor, 14:48666 (R;US)
Brooks, R.T. Jr., *See* Wright, L.L., 14:47030
Broomfield, B.J., Management program for underground storage tanks at the Idaho National Engineering Laboratory, 14:47779 (RA;US)
Bross, A., Scintillating fiber ribbon — tungsten calorimeter, 14:47807 (R;US)
Brotherton-Ratcliffe, D., On the solution of the rotamak current drive equations by expansion in vector spherical harmonics, 14:48625 (RA;AU)
Transverse oscillating field current drive in spherical plasmas, 14:48613 (RA;AU)
See Xu, S., 14:48597, 14:48620
Broughton, J.Q., Electronic properties of liquid silicon, 14:47452 (BA;US)
Brouwer, J., *See* Cameron, C.D., 14:47773
Browder, T.E., *See* Adler, J., 14:48321
Brown, D.W., *See* Tester, J.W., 14:47056
Brown, G.S., *See* Thompson, A.C., 14:47459
Brown, I.G., *See* Swift, P., 14:48270
Brown, J.A., Development for centrifuge modeling of buried explosions, 14:47910 (RA;US)
Brown, J.M., *See* Welch, K.M., 14:47801
Brown, J.S., *See* Adler, J., 14:48321
Brown, K.G., *See* Alvar, K.R., 14:47730
Brown, R.C., *See* Yetter, R.A., 14:47622
Brown, S., [Collection of data on tropical forest inventories, Rome, Italy, March 20–25, 1989]: Foreign trip report, 14:47035 (R;US)
Brown, T.H., *See* Perkins, E.H., 14:48170
Browning, D.S., *See* St. Clair, G.T., 14:46953
Broxton, D.E., *See* Bolivar, S.L., 14:46970
Brunner, P., *See* Ambach, W., 14:47992
Brusilovets, A.I., NMR study of addition products of metal alkoxides with low-coordinated phosphorus compounds, 14:47496 (RA;SU;In Russian)
Bruton, C.J., Predicting mineral dissolution and precipitation during burial: Synthetic diagenetic sequences, 14:47065 (RA;US)
See Wilson, C.N., 14:46980
Bryant, R.S., MEOR [microbial enhanced oil recovery] data base and evaluation of reservoir characteristics for MEOR projects, 14:46891 (R;US)
Bryukhova, E.V., *See* Volkov, S.V., 14:47510
Bublik, Zh.N., *See* Zub, V.N., 14:47498
Bucciarelli, G., *See* Struble, G.L., 14:47245
Buchanan, J.A., *See* Love, W.A., 14:47839
Buchau, J., *See* Anderson, D.N., 14:48233
Buchner, J., *See* Walden, T.L., 14:48119
Buck, J.W., *See* Droppo, J.G. Jr., 14:47921
See Hoopes, B.L., 14:46993
Buckmaster, J., Anomalous Lewis number effects in tribrachial flames, 14:47672 (BA;US)
Bulla, W., Relativistic corrections for the scattering matrix, 14:48565 (RA;AT;In German)
Bulmer, R.H., *See* Devoto, R.S., 14:48693
Bumpus, S.E., Benchmarking of the computer code and the thirty foot side drop analysis for the Shippingport RPV/NST package, 14:47729 (R;US)
Bunicci, J., *See* Zhang, W., 14:47802
Bunker, S., *See* Yamada, T., 14:47919
Bunker, W.J., *See* Leclaire, R.J. Jr., 14:47795
Bunnell, K.O., *See* Adler, J., 14:48321
Burcat, A., *See* Segev, G., 14:47692
Burchell, M., *See* Adler, J., 14:48321
Burgess, A.R., Pre-ignition phenomena and their effects on overall combustion rates of coal slurry droplets, 14:46878 (BA;US)
Burkart, W., Radiation protection survey of research and development activities initiated after the Chernobyl accident. Review report, 14:47143 (R;XN)
Burke, F.P., Donor hydrogen depletion in coal liquefaction, 14:46793 (R;US)
See Winschel, R.A., 14:46818
Burke, K., *See* Koeberl, C., 14:48199
Burkhard, N.R., Applications of vertical seismic profiling at NTS, 14:47894 (RA;US)
Estimation of the bulk diffusivity of chimneys using post-shot holes, 14:47904 (RA;US)
Burkhart, G.R., Collisionless tearing instability of a bi-Maxwellian neutral sheet with exact particle orbits. Interim report, 14:48583 (R;US)

Burman, R.L., *See* Haines, T.J., 14:48183
Burmeister, M., High temperature rate coefficient for the reaction CN + O_2 → NCO + O using different CN-sources, 14:47636 (BA;US)
Burnett, S.M., Electric quadrupole moments of the first excited states of ^{130,134,138}Ba, 14:48451 (R;AU)
See Spear, R.H., 14:48449
Burnett, T.H., *See* Adler, J., 14:48321
Burson, S.B., United States Nuclear Regulatory Commission research program on molten core debris interactions in the reactor cavity, 14:47164 (J;NL)
Bush, S.P., *See* Rankin, W.N., 14:46955
Butler, P.L., Design and implementation of a parallel computer for expert system applications, 14:48739 (BA;US)
Butler, T.D, *See* McKinley, T.L., 14:47311
Butler, W.H., *See* Allen, P.B., 14:48536
Butt, D.P., Study of the corrosion of ceramic materials in a simulated advanced glass melter flue-gas environment. Topical report, June 1987-May 1988, 14:47403 (R;US)
Buttram, M.T., Suppression of volume breakdown in vacuum with coatings, 14:47448 (R;US)
See Vandevender, J.P., 14:48692
Bychuk, O.V., *See* Gavrin, V.N., 14:48318
Byerly, G.R., *See* Lowe, D.R., 14:48201
Byers, F.M., *See* Bolivar, S.L., 14:46970
Bykov, V.N., Effect of high temperature annealings on swelling and helium release in boron carbide irradiated with neutrons, 14:47393 (RA;SU;In Russian)
Bykov, V.P., Strong quantum-mechanical instability of orbital motion of a macroscopic body in a gravitational field, 14:48570 (RA;SU;In Russian)
Byrne, A.P., *See* Dracoulis, G.D., 14:48453
See Stuchbery, A.E., 14:48454
Bystrov, L.N., Creep of bcc-alloys based on Fe under conditions of cyclic irradiation, 14:47365 (RA;SU;In Russian)

C

Cabaj, A., *See* Keck, G., 14:47960
Cable, A.S., Data acquisition and monitoring of radwaste cementation plants, 14:46964 (R;GB)
Cabot, G., *See* Stepowski, D., 14:47591
Cady, D.R., *See* Haines, T.J., 14:48183
Caldwell, J.T., Nondestructive assay and real-time radiography requirements for remote-handled wastes at the proposed WHPP facility, 14:46937 (RA;US)
Callahan, T.J, *See* Ryan, T.W., 14:47308
Calo, J.M., *See* Perkins, M.T., 14:46822
See Suuberg, E.M., 14:47559
Cameron, C.D., A model gas turbine combustor with wall jets and optical access for turbulent mixing, fuel effects, and spray studies, 14:47773 (BA;US)
Camp, J., *See* Dyer, P., 14:48359
Campbell, C.T., Model Cu/ZnO catalysts for methanol synthesis: The role of surface structure: Progress report, 14:47025 (R;US)
Campbell, D.K., *See* Vogl, P., 14:47431
Campbell, J.A., *See* Pyne, J.W., 14:46804
Campbell, R.B., *See* Devoto, R.S., 14:48693
Campbell, R.L., *See* Guidry, F.K., 14:46906
Campuzano, J.C., *See* Arko, A.J., 14:48531
Canales, T.W., An expert system for automating security incident assessment using OPS5 in an Ada environment, 14:47771 (BA;US)
Canavan, G.H., Comparison of laser and neutral particle beam discrimination, 14:48752 (R;US)
Candel, S., *See* Poinsot, T., 14:47657
Cant, R.S., Strained laminar flamelet calculations of premixed turbulent combustion in a closed vessel, 14:47609 (BA;US)
Cantwell, B.J., *See* Lewis, G.S., 14:47580
Cap, F., Toroidal parallel flow in Tokamaks, 14:48589 (RA;AT;In German)
Caprihan, A., *See* Assink, R.A., 14:46897
Carangelo, R.M., *See* Solomon, P.R., 14:46863
Carciello, N.R., *See* Sugama, T., 14:47414
Carinena, J.F., Theory of singular Lagrangians, 14:48543 (R;XA)
Carlip, S., Bordered surfaces, off-shell amplitudes, sewing, and string field theory, 14:48385 (R;US)
Carlos, B.H., *See* Bolivar, S.L., 14:46970
Carlson, K.D., *See* Williams, J.M., 14:47347
Carlson, R.L., Toxic chemical report, first annual: a summary of information contained in the toxic chemical report forms for calendar year 1987. Final report, 14:47226 (R;US)
Carlson, R.V., *See* Anderson, J.L., 14:47166
Carnes, N., Trends in state and local regulations of the transportation of hazardous and radioactive materials, 14:47009 (RA;US)
See Stancell, D.F., 14:47219
Carnes, S.A., Disposing of the US chemical weapons stockpile. An approaching reality, 14:48156 (J;US)
Carpenter, J.A. Jr., [Program for measurements and models of grain boundary and surface energies of metals and ceramics]: Foreign trip report, March 7–17, 1988, 14:47373 (R;US)
See Eberhardt, J., 14:47380
Carpenter, R.B. Jr., Lightning safe environment for hazardous materials, 14:47221 (RA;US)
Carr, D.J., *See* Yeasted, J.G., 14:47222
Carrier, R.F., *See* Foley, R.D., 14:47995, 14:47996
Carroll, L.J., *See* Bonvin, E., 14:48292
Carson, D., *See* Legrand, A.P., 14:46837
Carter, G.M., *See* Luchente, M., 14:47737
Carter, M.R., A microchannel plate intensified, subnanosecond, x-ray imaging camera, 14:47838 (R;US)
Caruso, J.J., Finite element applications to explore the effects of partial bonding on metal matrix composite properties, 14:47436 (R;US)
Case, J., *See* Tsang, I., 14:46944
Cashdollar, K.L., Effect of volatility on dust flammability limits for coals, gilsonite, and polyethylene, 14:46842 (BA;US)
Casperson, D.E., *See* Kyrala, G.A., 14:48273
Cass, A.J., *See* Bonvin, E., 14:48292
Cassell, R.E., *See* Adler, J., 14:48321
Castro, D.E., Threshold for fatigue crack propagation, 14:47348 (R;DE;In German)
Catford, W.N., Study of ^{51}Ca via three-neutron transfer, 14:48446 (R;AU)
See Orr, N.A., 14:48441, 14:48442
Cathonnet, M., *See* Chakir, A., 14:47617
Cattolica, R.J., Laser-fluorescence measurements of nitric oxide in low-pressure H_2/O_2/NO flames, 14:47640 (BA;US)
Cavaliere, A., Analysis of diesel sprays through two-dimensional laser light scattering, 14:47470 (BA;US)
Cavazos, A.P., *See* Hawkins, W.L., 14:47909
Cavolowky, J.A., *See* Cattolica, R.J., 14:47640
Cavolowsky, J.A., *See* Lucas, D., 14:47684
Celik, I., Computational fluid dynamics assessment: Volume 1, Computer simulations of the METC [Morgantown Energy Technology Center] entrained-flow gasifier: Final report, 14:46815 (R;US)
Cetegen, B.M., Study of molecular mixing and a finite rate chemical reaction in a mixing layer, 14:47577 (BA;US)
Chadaeva, N.A., *See* Galeev, A.M., 14:47493
Chael, E.P., Seismic verification studies at Sandia, 14:47916 (R;US)
Chakir, A., Kinetic study of 1-butene oxidation in a jet-stirred flow reactor, 14:47617 (BA;US)
Chamis, C.C., *See* Caruso, J.J., 14:47436
Champeny, L., *See* Osborn, J., 14:47194
Champion, M., *See* Bray, K.N.C., 14:47606
Chan, C.K., The structures of fast deflagrations and quasi-detonations, 14:47690 (BA;US)
Chan, K.C., Minimized emittance growth with elliptical beam pipes in FEL [free-electron-laser], 14:47743 (R;US)
Chan, S.H., Equilibrium computations of multiphase nonideal electrolytic systems and structure of turbulent reacting dissolving jets, 14:47601 (BA;US)
Chan, S.W., *See* Stubington, J.F., 14:46871
Chan, Y.D., *See* Namboodiri, M.N., 14:48460
Chandra, D., Desulfurization of coal by bacterial means, 14:46810 (RA;US)
Chang, A.Y., *See* Davidson, D.F., 14:47538
Chang, C.Y., *See* Haines, T.J., 14:48183
Chang, D.P.Y., *See* Sorbo, N.W., 14:47709

Chang, Hsi-Tien, Prototype Borehole Directional Radar System, 14:47852 (R;US)
Chang, J.D.L., *See* Davis, B.C., 14:47911
Chang, L.L., *See* Bleuse, J., 14:47413
Chang, S.L., System simulation and comparison of advanced flue gas clean-up processes in coal-fired power plant using salt code, 14:47078 (R;US)
Chang, W.D., Chemical structure of fuel-rich, premixed, laminar flames of trichloroethylene, 14:47664 (BA;US)
Chang, Y.A., [Thermodynamics, kinetics, and interfare morphologies of phase formation reactions between metals and gallium arsenide: Bulk vs thin-film studies], 14:47420 (R;US)
Chao Wei-Qin, Factors in EMC effect, 14:48471 (RA;PL)
Chapatwala, K.D., Isolation and identification of microorganisms capable of degrading common laboratory solvents, 14:47224 (RA;US)
Chaplin, M.R., *See* Shen, S.S., 14:48694
Chapman, C.R., Risk to civilization: A planetary science perspective, 14:48192 (RA;US)
Chaput, L.S., *See* Neulicht, R.M., 14:47948, 14:47949
Charest, J.A., *See* Hearst, J.R., 14:47897
Charles, D., *See* Vong, R., 14:47936
Chase, J.B., *See* Cutting, J.L., 14:47768
Chashej, I.V., Wave sources of momentum and heat in solar wind, 14:48181 (RA;SU;In Russian)
Chatham, H., Preparation and properties of high deposition a-Si:H films and solar cells using disilane: Final subcontract report, 1 May 1988–30 April 1989, 14:47041 (R;US)
Chattree, M., *See* Celik, I., 14:46815
Chauveau, C., *See* Gokalp, I., 14:47710
Chekin, V.V., *See* Igrushin, V.V., 14:47363
Chelikowsky, J.R., Empirical methods for predicting the phase diagrams of intermetallic alloys, 14:47342 (RA;US)
Chen Hao, Further studies on possible coexistence of antiferromagnetism and superconductivity in 2D Heisenberg model, 14:48530 (R;XA)
Chen, J., *See* Burkhart, G.R., 14:48583
See Finn, J.M., 14:48175
Chen, K.C., *See* Mazdiyasni, K.S., 14:47713
Chen, L.D., Buoyant diffusion flames, 14:47596 (BA;US)
Chen, L.F., *See* Wu, C.K., 14:46861
Chen, M.M., Solids motion and heat transfer in gas fluidized beds, 14:47756 (BA;US)
Chen, Rueyhung, The role of the recirculation vortex in improving fuel-air mixing within swirling flames, 14:47582 (BA;US)
Chen, S.L., Advanced NO_x reduction processes using -NH and -CN compounds in conjunction with staged air addition, 14:46874 (BA;US)
See Slaughter, D.M., 14:46876
Chen, Z., *See* Bradley, D., 14:47693
Cheng, H.Y., Status of the $\Delta I = 1/2$ rule in Kaon decay, 14:48381 (J;US)
Cheng, R.K., Reaction rates in premixed turbulent flames and their relevance to the turbulent burning speed, 14:47607 (BA;US)
See Cho, P., 14:47603
Cheng, W.K., *See* Pope, S.B., 14:47608
Cheong, S.W., *See* Arko, A.J., 14:48531
Chernova, R.K., Spectroscopic study of hydrophobic interactions in coordination compounds with ligands modified by surfactants, 14:47506 (RA;SU;In Russian)
Chernyj, B.P., *See* Volkov, E.D., 14:47368
Chernykh, E.V., *See* Tomilova, L.G., 14:47504
Chernyshov, V.A., *See* Dorokhova, N.I., 14:47488
Chetverikov, A.P., *See* Ljadov, G.D., 14:47090
Chetyrkin, K.G., Simple proof of renormalization group equation in the minimal subtraction scheme, 14:48386 (R;XA)
Chevalier, J.L., Design and construction of thermal solar equipments: flat plate solar collectors, 14:47048 (R;FR;In French)
Chiche, P., *See* Legrand, A.P., 14:46837
Chidume, C.E., Approximation method for nonlinear integral equations of Hammerstein type, 14:48548 (R;XA)
Existence, uniqueness and approximation of a solution for a K-positive definite operator equation, 14:48549 (R;XA)
Chien, P.L., *See* Solomon, P.R., 14:46863
Chieux, P., *See* Boucher, B., 14:47334
Childress, S., *See* Stefanski, R., 14:47784
Chipera, S.J., *See* Bolivar, S.L., 14:46970
Chirone, R., Primary fragmentation of a coal in fluidized bed combustion, 14:46869 (BA;US)
Chiu, Y.T., *See* Davidson, G.T., 14:48235
Cho, P., Velocity and scalar fields of turbulent premixed flames in stagnation flow, 14:47603 (BA;US)
Cho, S.Y., *See* Yetter, R.A., 14:47622
Christie, W.H., *See* Aziz, M.J., 14:47458
Christopher, P., *See* Jaffe, P.R., 14:48030
Christova, E.Ch., *See* Bilenky, S.M., 14:48337
Chrysty, J.P., *See* Demcko, J.A., 14:47764, 14:47765
Chuma, N.J., *See* White, A.F., 14:47062
Chun, Kwang Min, Prediction of knock occurrence in a spark-ignition engine, 14:47302 (BA;US)
Chung, F.T.H., *See* Llave, F.M., 14:46892
Chung, H.M., Thermal aging of some decommissioned reactor components and methodology for life prediction, 14:47084 (R;US)
Chung, S.U., *See* Bonvin, E., 14:48292
Church, Z., Local implementation by New England municipalities of the Emergency Planning and Community Right-To-Know Act of 1986 (Title 3 of SARA) (Superfund Amendments and Reauthorization Act). Technical report (Final), 14:47228 (R;US)
Churchill, S.W., *See* Strenger, M.R., 14:47642
Chvankin, E.V., *See* Vlaskin, G.N., 14:47091
Ciajolo, A., *See* Barbella, R., 14:47707
Claesson, G., *See* Plasil, F., 14:48458
Clark, N.A., *See* Rieker, T.P., 14:47432
Clarke, A.N., *See* Wilson, D.J., 14:47980
Claus, H., *See* Arko, A.J., 14:48531
Clausen, E.C., Biological conversion of synthesis gas into liquid fuels, 14:46800 (RA;US)
Clay, J.P., Kernville ammonia system, 14:47914 (R;US)
Clayton, C.R., *See* Sugama, T., 14:47414
Clewing, G., *See* Plasil, F., 14:48458
Cline, S., *See* Vong, R., 14:47936
Cline, T.L., *See* Schaefer, B.E., 14:48230
Coats, C.J., *See* Young, J.O., 14:47954
Coats, C.M., Transition and stability of turbulent jet diffusion flames, 14:47597 (BA;US)
Cobble, J.A., *See* Kyrala, G.A., 14:48273
Cochran, J.W., Modified purge-and-trap/gas-chromatography method for analysis of volatile halocarbons in microbiological degradation studies (journal version), 14:48031 (R;US)
Coffey, H.E., Solar-Geophysical Data Number 534, February 1989. Part 1 (prompt reports). Data for January 1989, December 1988, and late data, 14:48219 (R;US)
Solar-Geophysical Data Number 535, March 1989. Part 1 (prompt reports). Data for February, January 1989, and late data, 14:48221 (R;US)
Solar-Geophysical Data Number 535, March 1989. Part 2 (comprehensive reports). Data for September 1988, and miscellaneous, 14:48222 (R;US)
Coffin, D.O., *See* Anderson, J.L., 14:47166
Coffman, D., *See* Adler, J., 14:48321
Cohen, J., Electromagnetic production of hypernuclei, 14:48322 (J;US)
Cohen, M.L., Pseudopotential calculations of structural properties of solids, 14:48526 (BA;US)
Cole, G.L., Initial operating capability for the hypercluster parallel-processing test bed, 14:48733 (R;US)
See Blech, R.A., 14:48732
Cole, J.A., *See* Chen, S.L., 14:46874
Cole, M.W., Atomic scattering as a probe of physical adsorption, 14:47417 (RA;US)
Coleman, G., Building Thermal Envelope Systems and Materials (BTESM) and research utilization/technology transfer progress report for DOE Office of Buildings and Community Systems: Monthly progress report, 14:47272 (R;US)
Coleman, R., *See* Stefanski, R., 14:47784
Collins, B.L., Evaluating office lighting environments: Second-level analysis, 14:47273 (R;US)

Collins, C.B., Demonstration of the feasibility of the tuning and stimulation of nuclear radiation. Final report, 1 July 1981-31 October 1988, 14:48445 (R;US)
Proof of the feasibility of coherent and incoherent schemes for pumping a gamma-ray laser. Quarterly technical progress report, 1 October-31 December 1988, 14:48462 (R;US)
Collins, G.A., Current drive and confinement in ANSTO large glass vessel, 14:48595 (RA;AU)
See Tendys, J., 14:48624
Comings, D.E., Spontaneous genomic instability in humans: Final report, 14:48086 (R;US)
Comolli, A.G., Two-stage, close coupled catalytic liquefaction of coal: Second quarterly report, January 1, 1989–March 31, 1989, 14:46821 (R;US)
Compton, E., Fate and transport of petroleum released from leaking underground-storage tanks in areas of karst topography. Technical report, 14:46900 (R;US)
Comsan, M.N.H., *See* Tag Eldin, I.M.A., 14:48467
Conaway, J., Temperature logging as an aid to understanding groundwater flow in NTS boreholes, 14:47908 (RA;US)
Conkle, H.N., *See* Litt, R.D., 14:46840
Connell, J.R., User's guide for a personal computer model of turbulence at a wind turbine rotor, 14:47073 (R;US)
Conner, C.R., *See* Yeasted, J.G., 14:47222
Connolly, R.C., *See* Weitkamp, W.G., 14:47806
Conti, A.J., *See* Hammack, W.S., 14:47527
Continillo, G., Numerical study of multicomponent fuel spray flame propagation in a spherical closed volume, 14:47705 (BA;US)
Conway, G.D., ECRH experiments on the SHEILA heliac, 14:48593 (RA;AU)
ECRH experiments using a 2.45GHz domestic microwave oven magnetron, 14:48612 (RA;AU)
Cook, J.P.D., *See* Minchinton, A., 14:48248
Cook, V., *See* Adler, J., 14:48321
Cool, T.A., Profiles of HCO and CH_3 in CH_4/O_2 and C_2H_4/O_2 flames by resonance ionization, 14:47462 (BA;US)
Cooper, G., Free boundary stability of helical plasmas using PEST25, 14:48633 (RA;AU)
Cooper, T.C., Evaluation of dustiness test methods and recommendations for improved dust control at Heubach Inc., Newark, New Jersey. Study report, 14:47942 (R;US)
Cooper, W.A., *See* Dewar, R.L., 14:48634
Copeland, R.A., *See* Kohse-Hoeinghaus, K., 14:47465
See Rensberger, K.J., 14:47466
Copus, E., *See* Burson, S.B., 14:47164
Corbett, J.W., *See* Mikkelsen, J.C., 14:47450
Corbyn, I.N., *See* Crockford, K.J., 14:47031
Cordill, C., *See* Hudson, B., 14:47900
Cornell, J.C., *See* Dostal, P.R., 14:47813
Corpuz, R.P., *See* Meyer, H.G., 14:48085
Correa, S.M., Non-premixed turbulent CO/H_2 flames at local extinction conditions, 14:47589 (BA;US)
Coss, J.R., *See* Nichols, D.K., 14:47437
Cottrell, G., *See* Besson, G., 14:48607
Couch, G.R., Recent progress in coal bioprocessing research in Europe, 14:46798 (RA;US)
Coughlin, P.J., Marine transportation and burial of the Shippingport Reactor Pressure Vessel/Neutron Shield Tank (RPV/NST) package, 14:47001 (R;US)
Coulomb, F., Domain decomposition method for solving the neutron diffusion equation, 14:48488 (R;FR;In French)
Court, L., *See* Mestries, J.C., 14:48138
See Roman, V., 14:48137
Courville, G.E., [Briefings on low slope roof system meetings]: Foreign trip report, June 4, 1989–June 15, 1989, 14:47271 (R;US)
Coward, D.H., *See* Adler, J., 14:48321
Cowser, D.K., *See* Schauss, R.D., 14:47197
Cox, D.E., *See* Eddy, M.M., 14:47529
Cox, R.J., *See* Walsh, P.M., 14:46867
Cox, T.L., *See* Strand, R., 14:48746, 14:48747
Cozzens, R.F., Analysis and evaluation of technical data on the photochromic and nonlinear optical properties of materials. Quarterly technical report No. 1, 14:48158 (R;US)
Craig, D.F., [Current research in advanced materials]: Foreign trip report, May 29–June 3, 1989, 14:47400 (R;US)
Craig, P.M., *See* Yager, R.E., 14:46951
Cramer, N.F., Quasilinear relaxation of electron distribution function, 14:48632 (RA;AU)
Cramer, S.N., *See* Lee, T.Y., 14:47116
Crane, S.L., Indexes for the proceedings of the symposia (international) on detonation, 1951 through 1985, 14:47855 (R;US)
Crawford, B.A., Photodynamics of a nickel hydrocorphinoid model of F_{430}, 14:47022 (J;US)
Creedon, R.L., *See* Tabor, M.A., 14:48704
Cremean, S.P., *See* Jahn, R.K., 14:47307
Crescitelli, S., *See* Di Blasi, C., 14:47643
Cresti, P., *See* Aparo, M., 14:46927
Creutz, M., Microcanonical Monte Carlo, 14:48579 (BA;US)
Criegee, L., Hadron production and search for new particles at DESY, 14:48305 (RA;PL)
Crijns, M., IAEA in-core fuel management activities, 14:47086 (RA;XA)
Crimi, F.P., Shippingport: Overall project progress, 14:47002 (R;US)
Criminale, W.O., Analytical and numerical studies in flow development: Progress report, 1 July 1988 to Present, 14:48284 (R;US)
Crisler, M., *See* Bross, A., 14:47807
Crocket, J.H., Noble metals in mid-ocean ridge volcanism: A significant fractionation of gold with respect to platinum group metals, 14:48193 (RA;US)
Crockford, K.J., Evaluation of the methodology for managing existing broadleaved and coniferous woodlands for timber and energy production, 14:47031 (R;GB)
Croft, L.D., INEL [Idaho National Engineering Laboratory] hot shop contamination control during TMI-2 [Three Mile Island Unit 2] core debris handling, 14:47198 (J;US)
Crook, A.E., Approaches to risk training: An evaluation of EPA (Environmental Protection Agency) risk training materials. Technical report, 14:47229 (R;US)
Crosley, D.R., *See* Kohse-Hoeinghaus, K., 14:47465
See Rensberger, K.J., 14:47466
Cross, R.C., Alfven waves in TORTUS, 14:48636 (RA;AU)
Crow, N.B., *See* Webster-Scholten, C.P., 14:47862
Crumpler, G., Sludge Incineration Model (SIM) (for microcomputers). Model-Simulation, 14:47298 (R;US)
Crutcher, J.W., *See* Foley, R.D., 14:47996, 14:47997, 14:47998
Cudworth, J.A., EPA (Environmental Protection Agency) and state authority over DOE (Department of Energy) groundwater radionuclides, 14:46997 (RA;US)
Cui, C.S., Experimental studies of parametric decay instability in the WOMBAT apparatus, 14:48638 (RA;AU)
Culbertson, R.J., *See* Pennycook, S.J., 14:47451, 14:47457
Curlee, R.M., *See* Watkins, R.D., 14:47446
Curtis, C.W., Interactive chemistry of coal-petroleum processing: Quarterly report, March 16, 1989–June 15, 1989, 14:46898 (R;US)
Curvers, A., Recommendations for a European wind turbine standard on performance determination, 14:47067 (R;NL)
Cutlip, R.G., *See* Kakwani, R.M., 14:46884
Cutting, J.L., High gain flux compression generator fabrication issues, 14:47768 (R;US)

D

D'Alessio, A., *See* Barbella, R., 14:47707
See Borghese, A., 14:47304
See Cavaliere, A., 14:47470
D'yachkova, T.A., Spectroscopic properties of heterovalent complexes of titanium, vanadium, iron, copper, 14:47521 (RA;SU;In Russian)
da Cruz, F.N., *See* Vandooren, J., 14:47678
Dabbous, H., Construction of a test cell for the laser calibration of the planar ZEUS drift chambers and studies of algorithms for the analysis of FADC signals, 14:47822 (R;DE;In German)
Dacal, A., *See* Namboodiri, M.N., 14:48460
Dahm, W.J.A., Coflowing turbulent jet diffusion flame blowout, 14:47610 (BA;US)

Dalbeck, B.W., GRI (Gas Research Institute) baseline projection regional summary. Topical report, January 1989, 14:47250 (R;US)
Dalgarno, B.G., Electron spin resonance studies of radiation effects in biological materials. An assessment of current and future research, 14:48120 (R;GB)
Dalichaouch, Y., *See* Torikachvili, M.S., 14:47330
Dallas, M.D., Intermediate-range nuclear forces (INF) treaty: History of an illusion, 14:47320 (R;US)
Damiano, F.A., *See* Anderson, J.L., 14:47166
Danaee, A., Multigrid techniques with non-standard coarsening and group relaxation methods, 14:48558 (R;XA)
Danilov, S.E., *See* Arbuzov, V.L., 14:47361
Dannert, V., Polyphase diffusion of fission products in graphite. A contribution about the safety of high temperature reactors, 14:47096 (R;DE;In German)
Danshin, S.N., *See* Gavrin, V.N., 14:48318
Dao-yi, XU, *See* Qin-Wen, ZHANG, 14:48215
Datz, S., [Atomic physics with large electrostatic accelerators]: Foreign trip report, May 14, 1989–June 9, 1989, 14:48520 (R;US)
[Workshop on ion cooler ring experiments]: Foreign trip report, May 2, 1988–May 13, 1988, 14:47818 (R;US)
Davenport, J.W., *See* Watson, R.E., 14:47331
David, S.A., *See* Maguire, M.C., 14:47374
Davidson, D.F., Laser photolysis shock tube for combustion kinetics studies, 14:47538 (BA;US)
Davidson, G.T., Nonlinear model of wave-particle interactions in the trapped radiation belts: Auroral-pulsation solutions, 14:48235 (R;US)
Davies, K.E., Effects of plasma confinement on deposition and etch rates, 14:48503 (RA;AU)
Davis, A.J., A comparison between Thiobacillus ferrooxidans and biological by-products in the desulfurization of coal fines in flotation, 14:46812 (RA;US)
Davis, B.C., Development of centrifuge modeling for evaluating the mechanisms of collapse of underground opening, 14:47911 (RA;US)
Davis, J.L., Polymerization and decarbonylation reactions of aldehydes on the Pd(111) surface, 14:47528 (J;US)
Davis, J.M. Jr., Automated data collection (ADC) extension of a generic computerized nuclear material accountability system, 14:47006 (R;US)
Davis, K.D., *See* Van Deusen, L.C., 14:47003
Davis, K.M., [Air Force asbestos management program]: Foreign trip report, August 16–September 3, 1988, 14:48144 (R;US)
Davis, M.J., *See* Dunning, T.H. Jr., 14:47262
Davis, S., On the domain of string perturbation theory, 14:48390 (R;XA)
Davletshin, A.Eh., *See* Arbuzov, V.L., 14:47361
Daw, C.S., *See* Krishnan, R.P., 14:46881
Dawes, S.S., *See* Williamson, A.D., 14:47951
Dawson, L.R., *See* Tigges, C.P., 14:48523
Dayi, O.F., On gauge fixing and quantization of constrained Hamiltonian systems, 14:48557 (R;XA)
Deal, W.E., *See* Crane, S.L., 14:47855
DeAngelis, D.L., [Effects of nutrient recycling and food chain length on resilience]: Foreign trip report, April 3–30, 1988, 14:47975 (R;US)
Deangelis, M., *See* Rocchia, R., 14:48206
Deb, S., *See* Pattipati, K.R., 14:48719
Deeter, J.E., Correlation between x-ray flux and rotational acceleration in Vela X-1. Final technical report, 14:48187 (R;US)
DeHope, W.J., *See* Mazdiyasni, K.S., 14:47713
Delany, J.M., EQ3/6 data base - Ongoing development at Lawrence Livermore National Laboratory, 14:46963 (RA;US)
Delemchuk, N.V., *See* Trachevskij, V.V., 14:47519
Delfau, J.L., *See* Bastin, E., 14:47562
Delfosse, L., The evolution of porosity during the combustion of char: The fractal approach and the statistic description, 14:47558 (BA;US)
Delichatsios, M.A., Effects of turbulence on flame radiation from diffusion flames, 14:47648 (BA;US)
DeLorenzi, G., *See* Hoover, W.G., 14:48280
Delos-Santos, K., *See* Bass, I.L., 14:47748
Deluca, E.E., Effects of Cosmions upon the structure and evolution of very low mass stars, 14:48189 (R;US)
Demcko, J.A., Self-calibrating power angle instrument: Volume 1, A functional overview: Final report, 14:47764 (R;US)
Self-calibrating power angle instrument: Volume 2, Theory, operation, and maintenance: Final report, 14:47765 (R;US)
Denisov, I.A., *See* Minyaev, A.I., 14:47524
Derskij, L.S., Radiospectroscopic detection of zirconium silicate defectness, 14:48511 (RA;SU;In Russian)
Dery, V.A., Eenie, meenie, minie, moe, where do Monument Valley tailings go?, 14:46948 (RA;US)
Desai, U.D., *See* Schaefer, B.E., 14:48230
DeSaussure, G., *See* Sabharwal, A., 14:48738
Deshpande, G.V., *See* Solomon, P.R., 14:46820
Desilva, S.L., Explosive volcanism, shock metamorphism and the K-T boundary, 14:48194 (RA;US)
Desourza, A.E., *See* Wyza, R.E., 14:46801
Desvousges, W.H., Communicating radon risk effectively: Radon testing in Maryland. Final report, 14:47965 (R;US)
Deupree, R.G., Trends in cavity collapse data, 14:47912 (RA;US)
DeVault, G.P., Preliminary surface ground motion calculations with the SHALE code, 14:47877 (RA;US)
Devoto, R.S., Projections for a steady-state tokamak reactor based on ITER, 14:48693 (R;US)
Dewanjee, M.K., Platelet thrombosis in cardiac-valve prostheses, 14:48102 (R;US)
Dewar, R.L., Beta limit of heliac plasmas, 14:48634 (RA;AU)
See Parker, R.D., 14:48584
See Pletzer, A., 14:48629
DeWitt, H.E., Properties of strongly coupled multi-ionic plasmas, 14:48228 (R;US)
Dey, T.N., Effective stress model for partially and fully saturated rocks, 14:48161 (R;US)
Di Blasi, C., Model of the flow assisted spread of flames over a thin charring combustible, 14:47643 (BA;US)
Di Maio, F.P., *See* Lignola, P.G., 14:47682
Diana, M., *See* Borghese, A., 14:47304
Diasamidze, Eh.M., Effect of implantation on microhardness of niobium and molybdenum, 14:47367 (RA;SU;In Russian)
Dibble, R.W., *See* Dahm, W.J.A., 14:47610
See Mansour, M.S., 14:47600
See Masri, A.R., 14:47590
Dick, J.J., *See* Forest, C.A., 14:47858
Dickerson, L.S., *See* Stewart, R.C., 14:46975
Dickson, F.J., Calcium uranium titanate - a new pyrochlore, 14:47554 (R;AU)
Didelez, J.P., *See* Frascaria, R., 14:48348
Diem, D.A., Field evaluation of a soil-gas analysis method for detection of subsurface petroleum hydrocarbon contamination, 14:47983 (RA;US)
Diercks, D.R., A review of failure analysis experience on coal-gasification pilot plant components, 14:46830 (BA;US)
Dietz, R.S., *See* McHone, J.F., 14:48204
Dingus, B.L., *See* Haines, T.J., 14:48183
Dinkelacker, M., Gas evolution and bubble formation on electrodes, 14:47017 (R;DE;In German)
Dion, G.M., *See* Haines, T.J., 14:48183
DiPietro, P.J., *See* Ferullo, A.F., 14:48033
Distenfeld, C.H., *See* Vallem, R.J., 14:47174
Dixon-Lewis, G., Structure and extinction limits of counterflow diffusion flames of hydrogen-nitrogen mixtures in air, 14:47665 (BA;US)
See Kee, R.J., 14:47667
Dobbins, R.A., *See* Megaridis, C.M., 14:47566
Dobrev, V.K., Classification of modular invariant partition functions for the twisted N=2 superconformal algebra, twisted SU(2) Kac-Moody algebra and D_{2K} parafermions, 14:48389 (R;XA)
Multiplet classification of highest weight modules over quantum universal enveloping algebras: The $U_q(sl(3,C))$ example, 14:48562 (R;XA)
Dockery, H.A., *See* Anderson, G.D., 14:47896
See Kusubov, A.S., 14:47885
Doclet, D., *See* Rocchia, R., 14:48206

Doctor, R.D., Cost-effective sulfur control strategies for the Great Plains gasification project, 14:46825 (BA;US)
Dodge, C.J., *See* Francis, A.J., 14:46839
Dodge, R.L., *See* Kawamura, T.A., 14:46939
Dodson, B.W., Techniques for recovery of shock-loaded samples, 14:47725 (R;US)
Dodson, W., Monte Carlo simulation of growth of crystalline and amorphous silicon, 14:47455 (BA;US)
Doggett, G., Environmental test report on the CTI-Cryogenics 1-watt integral Stirling cooler (long-life HD-1033d). Final report, 16 June-24 July 1988, 14:47715 (R;US)
Doherty, M.F., A design and synthesis procedure for homogeneous and heterogeneous azeotropic distillations: Final report, March 1, 1985–February 29, 1988, 14:47718 (R;US)
Dole, L.R., In situ immobilization of PCBs at Pepper's Steel and Alloys site establishes a precedent as permanent remedy for nonvolatile organics, 14:47979 (RA;US)
Dollar, M., *See* Walston, W.S., 14:47381
Domenico, B.A., Application of the generalized newton-raphson method to the singly-ionized calcium line formation problem in model stellar atmospheres. Doctoral thesis, 14:48220 (R;US)
Dominici, D., Effective Lagrangian describing new vector mesons in a strong interacting Higgs sector, 14:48329 (RA;PL)
Donahue, B., *See* Martino, L.E., 14:47214
Donnat, M., *See* Bonvin, E., 14:48292
Donnelly, I.J., Ionisation processes in low pressure N_2 plasmas, 14:48610 (RA;AU)
Review of RF current drive, 14:48602 (RA;AU)
Rotating magnetic field current drive in hot plasmas, 14:48604 (RA;AU)
Donnelly, K.E., Evaluation of IREQ [Research institute of Hydro Quebec] electromagnetic dosimeter performance, 14:48160 (R;CA)
Donohue, M.L., *See* Struble, G.L., 14:47245
Dorchak, T.P., *See* Bedick, R.C., 14:46879
Dorey, S., Free trade on the prairies. The implications of the Canada-U.S. trade pact for the three prairie provinces, 14:47251 (R;CA)
Dorian, R., *See* Rose, S., 14:48084
Dorokhova, N.I., ESR of the first members of copper and vanadyl metal chelates of 2-acetylbenzimidazole thiosemicarbazones, 14:47488 (RA;SU;In Russian)
Dorsaz, P.A., *See* Bonvin, E., 14:48292
Dostal, P.R., Specifications for k=600 magnetic spectrometer components, 14:47813 (R;ZA)
Douse, V., *See* Wagh, A.S., 14:47389
Dowding, R.J., Recrystallization and respheroidization of tungsten grains in a tungsten-heavy alloy. Final report, 14:47328 (R;US)
Dracoulis, G.D., Band crossing in ^{170}Os, 14:48453 (R;AU)
Properties of $15/2^-$ states in ^{215}Ra and ^{217}Th; evaluation of the $15/2^-$ to $9/2^+$ E3 strength in N=127 isotones, 14:48456 (R;AU)
See Stuchbery, A.E., 14:48454
Draglia, R., *See* Maddever, R.A.M., 14:48608
Dragon, L., *See* Plasil, F., 14:48458
Dragt, J.B., Error analysis in the determination of the power performance of wind energy conversion systems, 14:47068 (R;NL)
Drake, M.C., *See* Haworth, D.C., 14:47588
Dransfeld, P., *See* Bley, U., 14:47537
Draper, H., *See* Wright, L.L., 14:47030
Dreffer, R., *See* Rockwell, R.J., 14:47939
Dreier, R.B., Hydrogeology of Melton Valley determined from hydraulic head measuring station data, 14:48027 (R;US)
Drellack, S.L. Jr., Definition of stratigraphic units between the Grouse Canyon and Rainier Mesa tuffs in Los Alamos-use areas of Yucca Flat, Nevada Test Site, 14:47892 (RA;US)
Dremin, I.M., Sensitivity of high-energy muon flux from atmosphere to parameters of hadronic charm production, 14:48239 (RA;SU;In Russian)
Dresner, L., Rational design of high-current cable-in-conduit superconductors, 14:48670 (R;US)
Dressler, B.O., Sudbury Structure (Ontario, Canada) and Vredefort Structure (South Africa): A comparison, 14:48195 (RA;US)
Drickamer, H.G., *See* Hammack, W.S., 14:47527
Driscoll, J.F., *See* Chen, Rueyhung, 14:47582
Droege, M.W., Conversion of methane to liquid hydrocarbons, 14:47019 (R;US)
Partial oxidation reactions of methane and oxygen, 14:47018 (R;US)
Dronova, T.V., *See* Afonin, M.A., 14:47517
Droppo, J.G. Jr., Characterization of the atmospheric pathway at hazardous waste sites, 14:47921 (RA;US)
Drost, M.K., *See* Ross, B.A., 14:47101
Druce, R.L., Subnanosecond linear GaAs photoconductive switching: Revision 1, 14:47727 (R;US)
Druzhkov, A.P., *See* Arbuzov, V.L., 14:47361
Dryer, F.L., *See* Yetter, R.A., 14:47622
Du, D.X., Experiments on the sooting limits of aerodynamically-strained diffusion flames, 14:47570 (BA;US)
DuCharme, A.R., Operational data collection and analysis for nuclear plant life extension, 14:47088 (R;US)
Dudareva, A.G., ^{127}I NQR study of holmium iodide compounds with monovalent metals, 14:47515 (RA;SU;In Russian)
Duff, R., *See* Peterka, D., 14:47883
Duff, R.E., Chemical considerations and containment, 14:47901 (RA;US)
Dugan, G., Tevatron collider: Status and prospects, 14:47783 (R;US)
Duggan, J.L., *See* McDaniel, F.D., 14:48281
Duke, C.B., The materials of xerography: A case study in the interaction of engineering and science, 14:47415 (RA;US)
Duke, J.C. Jr., Study of the stress wave factor technique for evaluation of composite materials. Final report, 14:47440 (R;US)
Dulleba, D.R., *See* Modica, L.G., 14:47969
Dunlop, J.A., Ultrapure materials for alpha particle-sensitive applications, 14:47555 (J;US)
Dunmire, H., *See* Doggett, G., 14:47715
Dunn, S.D., *See* Keller, C., 14:47882
Dunning, T.H. Jr., Theoretical studies of chemical reactions: Pyrolysis of formaldehyde, 14:47262 (RA;US)
Duong Minh Duc, Mixed singular linear elliptic equations, 14:48541 (R;XA)
Dupuy, J., *See* Beyeler, W., 14:46947
Durance, G., *See* Collins, G.A., 14:48595
Duranceau, S.J., *See* Taylor, J.S., 14:48038
Durand, T., *See* Finkbeiner, F., 14:47281
Durant, J.F., Impacts of cleaning Texas lignite on boiler performance and economics: Final report, 14:46880 (R;US)
Duru, I.H., Casimir force between two Aharonov-Bohm selenoids, 14:48393 (R;XA)
Dutch, M., *See* Besson, G., 14:48607
Dutta, A., *See* Walsh, P.M., 14:46867
Dvoretskij, V.G., *See* Ljadov, G.D., 14:47090
Dwight, K., *See* Niu, C.M., 14:47387
Dwyer, H.A., Calculations of unsteady reacting droplet flows, 14:47703 (BA;US)
See Lutz, A.E., 14:47686
Dybel, M., *See* Harsh, D., 14:46807
Dyer, P., Falling antimatter: An experiment to measure the gravitational acceleration of the antiproton, 14:48359 (J;NL)
Dykhuizen, R.C., Fluid dynamics of a pressure measuring system for underground explosive tests, 14:47899 (RA;US)
Dzikowski, R.J., *See* Vervaet, D., 14:47192

E

East, B.W., Measurement of radioactivity from Chernobyl in population groups in Scotland, 14:47991 (R;GB)
Eberhardt, J., Materials by design, 14:47380 (BA;US)
See Fassbender, L.L., 14:47294
Eberhardt, J.J., Purposes of the assessment, 14:47323 (RA;US)
Ebert, P.J., Non-intrusive verification, 14:47917 (R;US)
Echenique, P.M., *See* Pitarke, J.M., 14:48527
Eddy, M.M., Inclusion tuning of nonlinear optical materials: Sorbates in the KTP structure, 14:47529 (J;US)
Edelbuettel-Einhaus, J., *See* Bartels, M., 14:47632
Edney, E.O., Paint coatings: Controlled field and chamber experiments, 14:47947 (R;US)
Edwards, G.R., *See* Maguire, M.C., 14:47374
Effelsberg, E., Scalar dissipation rates in turbulent jets and jet diffusion flames, 14:47598 (BA;US)

Efremov, A.V., Check of colour symmetry at the LEP collider, 14:48353 (RA;SU)
Egekeze, J., *See* Geng, L., 14:47535
Egger, J.P., *See* Frascaria, R., 14:48348
Eggleton, A.E.J., *See* Sandalls, F.J., 14:47988
Eguchi, Tohru, Application of superconformal symmetry to string compactification, 14:48363 (RA;JP)
Ehbrecht, J., *See* Baetz, P., 14:47639
Eichinger, J.R., *See* Young, J.O., 14:47954
Eijaervi, E., Composting of surface peat, waste water sludge and bark, the properties and suitability of substietes for growing media for landscaping, 14:47038 (R;FI;In Finnish)
Einstein, T.L., Lateral interactions in adsorption: Revelations from phase transitions, 14:47337 (RA;US)
Eisen, F.H., *See* Appleton, B.R., 14:47449
Eisenberg, J.K., *See* Gossett, C.A., 14:47805
Eisl, M., Mass-spectrometric depth profile analysis of $YBa_2Cu_3O_x$ single crystals, 14:47422 (RA;AT;In German)
Eisner, H., *See* Ambach, W., 14:47992
El-Ashry, M.Y., Ion-sound emission by Langmuir soliton crossing density barrier, 14:48586 (R;XA)
Possibility of low-frequency electron wave in a beam-plasma system, 14:48587 (R;XA)
Eldering, C.A., *See* Kowel, S.T., 14:47849
Elliott, J.F., Physical chemistry of carbothermic reduction of aluminum: Final report, 14:47485 (R;US)
Elphic, R.C., Observations of flux transfer events: Are FTEs flux ropes, islands, or surface waves?, 14:48240 (R;US)
Emami, M., *See* Perry, A.J., 14:48505, 14:48606
Emanuel, W.R., [Analysis of vegetation responses to changes in the global environment]: Foreign trip report, March 29, 1989–April 7, 1989, 14:47932 (R;US)
[Development of a global vegetation model]: Foreign trip report, February 15–20, 1988, 14:47927 (R;US)
Embacher, G., 2D axial anomaly without ambiguity, 14:48405 (RA;AT;In German)
Embacher, H.G., Non-perturbative 2D axial-vector-current anomaly, 14:48406 (RA;AT;In German)
Embury, M.C., Operating experience with the hydrogen isotope separation system at MOUND, 14:48701 (J;US)
Emel'yanova, E.N., *See* Antonov, P.G., 14:47514
Eng, R., *See* Tsang, I., 14:46944
Epner, E.P., Locating and estimating air-toxics emissions from municipal-waste combustors. Final report, August 1988-March 1989, 14:47955 (R;US)
Erbert, G.V., *See* Bass, I.L., 14:47748
Erickson, D.G., *See* Tollefson, D.A., 14:47113
Erickson, K.L., Powder morphology effects in the ignition of titanium-based pyrotechnics, 14:47860 (R;US)
Erickson, L.M., *See* Urtiew, P.A., 14:47864
Ernest, A.D., Comparison of multi- and single-mode C.W. laser-induced perturbations of the 1S5 states in neon, 14:48600 (RA;AU)
Vibrational and penning-type influences of impurities on excitation and ionization in nitrogen, 14:48267 (RA;AU)
Eroshkina, L.A., *See* Gavrin, V.N., 14:48318
Errede, D., A high rate transition radiation detector for particle identification in a hadron beam, 14:47825 (R;US)
Erskine, D.J., Calculation of the refractive index change in dissociating shocked benzene, 14:48524 (R;US)
VISAR wave profile measurements in supra-compressed HE, 14:47863 (R;US)
Erwin, M.G., *See* Embury, M.C., 14:48701
Esmael, E.H., *See* Tag Eldin, I.M.A., 14:48467
Espenson, J.H., *See* Bakac, A., 14:47532, 14:47533
See Ram, M.S., 14:47023
Esposito, E., *See* Poinsot, T., 14:47657
Essenhigh, R.H., An integration path for the carbon-oxygen reaction with internal reaction, 14:47560 (BA;US)
Ignition of coal particles, 14:46885 (J;US)
Esser, B.K., *See* Turekian, K.K., 14:48210
Estulin, I.V., *See* Schaefer, B.E., 14:48230
Etkin, A., *See* Love, W.A., 14:47839
Eudier, M., *See* Joulin, G., 14:47677
Euringer, P., *See* Brand, M., 14:47255
Evans, G.H., *See* Kee, R.J., 14:47667
Evans, P.J., Isotope separation in the vacuum arc centrifuge, 14:47011 (RA;AU)
Evans, S., A structural study of a propane-oxygen diffusion flame diluted with argon, 14:47662 (BA;US)
Evans, W.D., *See* Schaefer, B.E., 14:48230
Evans, W.J., Utility of cyclodichlorophosphazene as a NaC_5H_5 scavenging reagent: Synthesis of an organoyttrium hydroxide complex and the x-ray crystal structure of the layered compound $((C_5H_5)_2Y(\mu\text{-}OH))_2$ ($C_6H_5C{\equiv}CC_6H_5$), 14:47531 (J;US)
Evans-Brown, B., *See* Bostick, W.D., 14:46968
Everett, K.R., *See* Walker, M.D., 14:47973
Evtikova, G.A., *See* Borisova, L.V., 14:47511

F

Faber, M., *See* Gasser, I., 14:48345
See Gerstenmayer, E., 14:48344
Fabrikant, J.I., *See* Levy, R.P., 14:48112
Faeth, F.M., *See* Kounalakis, M.E., 14:47649
Fahr, A., Reactions of vinyl and phenyl radicals with ethyne, ethene and benzene, 14:47630 (BA;US)
Faison, B.D., *See* Scott, C.D., 14:46806
Faizov, E.L., *See* Gavrin, V.N., 14:48318
Fakoussa, R.M., Partial degradation of untreated, hard coal by microorganisms, 14:46802 (RA;US)
Falaleev, O.V., *See* Zeer, Eh.P., 14:47525
Falconer, I.S., *See* Studer, A., 14:48269
See Swift, P., 14:48270
See Turner, G.M., 14:48502
See Wright, W., 14:48601
Fales, J.L., Using PATRAN: From eyeballs to submarines and more, 14:48727 (R;US)
Fallon, P.T., *See* Steinberg, M., 14:46792
Fan, B.C., A comprehensive model for the structure of dust detonations, 14:47691 (BA;US)
Fang, H.T., *See* Yeh, H.C., 14:47395
Farnsworth, R.K., The compatibility of various polymeric liner and pipe materials with simulated double-shell slurry feed at 90°C: Hanford Grout Technology Program, 14:46933 (R;US)
Farrell, J.B., *See* Adams, R.C., 14:47950
Farrow, R.L., *See* Rahn, L.A., 14:47464
Farthing, W.E., *See* Williamson, A.D., 14:47951
Fasham, M.J.R., [North Atlantic seasonal ecosystem model]: Foreign trip report, January 16–21, 1989, 14:48171 (R;US)
Fassbender, L.L., Catalysis by design: A coordinated approach to catalyst research and development, 14:47294 (R;US)
Fathy, D., *See* Ravindra, N.M., 14:47406
Fatome, M., *See* Mestries, J.C., 14:48138
See Roman, V., 14:48137
Faulkner, M.A., *See* Voorhees, L.D., 14:46999
Fauska, H., *See* Weitkamp, W.G., 14:47806
Fawaz, S.A., Compressive properties of high-performance polymeric fibers. Interim report, April-December 1988, 14:47412 (R;US)
Faymon, K.A., *See* Perez-Davis, M.E., 14:47263
Febo, A., *See* Hering, S.V., 14:47937
Fedorov, V.I., *See* Boguslavskij, A.A., 14:47513
Fedorova, V.A., *See* Kovchur, S.G., 14:48510
Feenstra, O., *See* Rabitsch, H., 14:48127
Feibelman, P.J., Electronic structure calculations for low coverage adlayers, 14:46794 (RA;US)
Fellmair, W., *See* Gerstenmayer, E., 14:48344
Fekete, P.W., *See* Brand, G.F., 14:48637
Feldbacher, R., Data libraries for fusion reactions in fusion fuels, 14:48675 (RA;AT;In German)
Feliks, M.E., *See* Bonvin, E., 14:48292
Felner, I., *See* Hilscher, G., 14:47425
Fendel, A., Characterization of sorbed oil components on clays and quartz grains in oil sand. A contribution to the wettability of reservoir rocks in petroleum deposits, 14:46920 (R;DE;In German)
Fendler, J.H., *See* Baral, S., 14:47540
Fenimore, E.E., *See* Schaefer, B.E., 14:48230

Fenker, H., *See* Errede, D., 14:47825
Fenster, R.A., Idealized proximity response of the DBS, 14:47890 (RA;US)
Fenstermacher, M.E., *See* Devoto, R.S., 14:48693
Ferguson, M.W., ^{13}C NMR analysis of the effects of electron radiation on graphite/polyetherimide composites. Final report, 14:47435 (R;US)
Ferguson, R.L., *See* Young, G.R., 14:48444
Ferkul, P.V., *See* Olson, S.L., 14:47644
Fernandez-Pello, A.C., *See* Bouhafid, A., 14:47650
See Di Blasi, C., 14:47643
Fernando, G.W., *See* Watson, R.E., 14:47331
Ferrante, J., *See* Smith, J.R., 14:47336
Ferraro, J.R., *See* Williams, J.M., 14:47347
Ferullo, A.F., Charles River lower basin artificial destratification project. Final report, 14:48033 (R;US)
Fessler, R.G., The role of risk assessment in remedial action cleanup programs (RACP): A case history, 14:46992 (RA;US)
Fetting, F., *See* Wieschnowsky, U., 14:47565
Fewell, M.P., *See* Burnett, S.M., 14:48451
See Ernest, A.D., 14:48267, 14:48600
See Lim, C.S., 14:48455
Fialkov, Yu.A., *See* Khomenko, V.S., 14:47508
Fiechtner, G.J., Determination of relative number density and decay rate for atomic sodium in an atmospheric premixed flame by Asynchronous Optical Sampling, 14:47468 (BA;US)
Fields, D.J., *See* Namboodiri, M.N., 14:48460
Fifield, L.K., *See* Catford, W.N., 14:48446
See Orr, N.A., 14:48441, 14:48442
Filen, H., *See* Staahlberg, P., 14:47020
Fillipucci, M.L., *See* Cutting, J.L., 14:47768
Findsen, E.W., *See* Crawford, B.A., 14:47022
Fine, J.M., *See* Sheppard, D., 14:48147
Finfrock, S.H., *See* Albrecht, R.W., 14:47124
See Tollefson, D.A., 14:47113
Finkbeiner, F., Heat exchangers: a strategic analysis, 14:47281 (R;FR;In French)
Finley, D.A., Calculation of integrated luminosity for beams stored in the Tevatron collider, 14:47794 (R;US)
Finn, J.M., Equilibrium of solar coronal arcades. Interim report, 14:48175 (R;US)
Finn, N., Thomson scattering system for TORTUS tokamak, 14:48619 (RA;AU)
See Wright, W., 14:48601
Finnegan, D.L., Iridium emissions from Hawaiian volcanoes, 14:48196 (RA;US)
Fischer, S.J., Radiance, soot, and temperature interactions in turbulent alcohol fires, 14:47646 (BA;US)
Fisher, A., *See* Garate, E.P., 14:48665
Fisher, M.V., Remote leak detection for the Compact Ignition Tokamak, 14:48705 (J;US)
See Tabor, M.A., 14:48704
Fisher, W.S., *See* Collins, B.L., 14:47273
Fisk, H.E., *See* Stefanski, R., 14:47784
Fisk, Z., *See* Arko, A.J., 14:48531
Fisson, F., *See* Gabano, J.D., 14:47301
Fitzsimmons, P.K., *See* Kawamura, T.A., 14:46939
Fix, J.J., *See* Lyon, M., 14:47837
Fleischauer, P.D., *See* Lince, J.R., 14:48495
Fletcher, E.A., High-temperature solar electrothermal processing. Final report, July 1982-March 1989, 14:47046 (R;US)
Fletcher, J., Spatial non-uniformity in discharges in low pressure helium and neon, 14:48246 (R;AU)
Fliflet, A.W., *See* Gold, S.H., 14:47772
Florence, A.L., *See* Fogel, M.B., 14:47872
Flower, W.L., An investigation of soot formation in axisymmetric turbulent diffusion flames at elevated pressure; 14:47574 (BA;US)
See Axelbaum, R.L., 14:47569
Floyd, L.M., *See* Foley, R.D., 14:47996
Fluri, L., *See* Bonvin, E., 14:48292
Flynn, P., *See* Leonard, G., 14:47305
Fogel, M.B., Effects of late time creep and cavity depressurization on the residual stress field, 14:47879 (RA;US)
Experimental and calculational study of wave/fault interaction, 14:47872 (RA;US)
See Patch, D.F., 14:47886
Fogelson, D.J., *See* Reed, R.P., 14:47444
Folles, M., Simulation of equilibrium segregation in alloys using the Embedded Atom method, 14:47379 (BA;US)
Foley, K.J., *See* Love, W.A., 14:47839
Foley, R.D., Results of the radiological survey at 9 Redstone Lane, Lodi, New Jersey (LJ069), 14:47995 (R;US)
Results of the radiological survey at 205 Main Street, Lodi, New Jersey (LJ075), 14:47996 (R;US)
Results of the radiological survey at 88 East Central Avenue, Maywood, New Jersey (MJ037), 14:47997 (R;US)
Results of the radiological survey at 142 West Central Avenue, Maywood, New Jersey (MJ041), 14:47998 (R;US)
Folk, R., *See* Kolnberger, S., 14:47358
Folkerts, T.J., Preparation and characterization of single phase $Ba_{1-x}K_xBiO_3$, 14:47405 (R;US)
Follansbee, P.S., The HEL [Hugoniot Elastic Limit] and rate-dependent yield behavior, 14:47370 (R;US)
Foltyn, E.M., *See* Axler, K.M., 14:46930
Fon, W.C., 19-state R-matrix calculation of the electron-photon coincidence parameters λ and —chi— for the electron excitation of 1^1s -> $3^{3,1}p$ in helium at 29.6 eV, 14:48258 (R;XA)
Fontijn, A., *See* Mahmud, K., 14:47536
Ford, A., The impact of performance standards on the uncertainty of the Pacific Northwest electric system: A final report on the hypersens analysis of CPAM [Conservation Policy Analysis Model], 14:47080 (R;US)
Ford, G.W.K., Prospects for fusion power: recent reports in Europe, 14:48680 (RA;AU)
Ford, P.C., *See* Spillett, C.T., 14:47541
Forest, C.A., Impulse time-integral function and Lagrangian analysis, 14:48287 (R;US)
Lagrangian analysis of MIV [Magnetic Impulse-Velocity] gauge experiments on PBX 9502 using the mass-displacement moment function, 14:47858 (R;US)
Forgy, C., *See* Gupta, A., 14:48714
Forsthuber, M., *See* Hilscher, G., 14:47357
See Wiesinger, G., 14:47356
Fortmann, R.C., *See* Koontz, M.D., 14:47952
Fortney, L.R., High energy physics: Progress report, December 1, 1988–November 30, 1989, 14:48289 (R;US)
Fossheim, K., Specific heat in mono-crystal YbCo: lambda-like anomalies at 90 and 229K, 14:47402 (R;NO)
Foster, D.E., *See* Witze, P.O., 14:47701
Fowler, M.M., *See* Namboodiri, M.N., 14:48460
Francis, A.J., Microbial dissolution of toxic metals from coal residues, 14:46839 (RA;US)
Francis, C.W., [Land disposal of solid waste]: Foreign trip report, March 13–21, 1988, 14:47297 (R;US)
Frank, G., *See* Behling, U.H., 14:47184
Frank, P., *See* Braun-Unkhoff, M., 14:47633
Frankel, K.A., *See* Levy, R.P., 14:48112
Frascaria, R., Hyperon-nucleon final state interaction in a pp -> K^+X experiment and the H_1^+ (2130) S = - 1 strange dibaryon, 14:48348 (R;FR)
Freed, K.F., Relationship between ab initio and semiempirical theories of electronic structure, 14:47325 (RA;US)
Freeman, G.B., *See* Lackey, W.J., 14:47408
Freese, J.M., *See* Braithwaite, J.W., 14:47207
Frei, Z., Surface energy from order parameter profile: At the QCD phase transition, 14:48416 (R;HU)
Frenklach, M., Basic research on natural gas combustion phenomena. Annual report, September 1987-August 1988, 14:46918 (R;US)
On the driving force of PAH (polycyclic aromatic hydrocarbons) production, 14:47635 (BA;US)
Frey, W.W., *See* Zhang, W., 14:47802
Fricke, A.L., A comprehensive program to develop correlations for the physical properties of kraft black liquors, 14:47283 (R;US)
Fricke, V., *See* Rainisch, R., 14:47175
Friedman, A., *See* Rambo, P.W., 14:48663
Friedrichs, D.L., *See* Hoopes, B.L., 14:46993

Frieman, J.A., New class of non-topological solitons, 14:48417 (R;US)
Fritz, I.J., *See* Tigges, C.P., 14:48523
Fritzer, H.P., *See* Gruber, H., 14:47426
Fritzsche, R.A., Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest): Pile perch, striped seaperch, and rubberlip seaperch, 14:48016 (R;US)
Fromherz, T., Recombination centres in electron- and neutron irradiated Si diodes, 14:47840 (RA;AT;In German)
Fromme, C., *See* Osborn, J., 14:47194
Frost, L., Orbital momentum distribution and binding energies for the complete valence shell of molecular chlorine by electron momentum spectroscopy, 14:48249 (R;AU)
Orbital momentum distribution and binding energies for the complete valence shell of molecular bromine, 14:48252 (R;AU)
Fruehwirth, R., Novel methods for reconstruction of events in experimental high-energy physics, 14:48314 (RA;AT;In German)
Fry, R.J.M., [Low dose radiation biological bases of risk assessment]: Foreign trip report, September 2-21, 1988, 14:48133 (R;US)
[Workshop on radiation research related to space stations and missions beyond the magnetosphere]: Foreign trip report, July 17–24, 1988, 14:48132 (R;US)
Frye, K., Introductory remarks, 14:46796 (RA;US)
Fu, C.Y., *See* Ingersoll, D.T., 14:48491
Fu, J.S., *See* Axness, C.L., 14:47821
Fuchs, M. and others, *See* Ackerbauer, P., 14:48673, 14:48678
Fujimoto, J.G., *See* Luchente, M., 14:47737
Fukushima, E., *See* Assink, R.A., 14:46897
Fuller, P., *See* Billaux, D., 14:48163
Funk, J.G., Effects of simulated space environmental parameters on six commercially available composite materials, 14:47434 (R;US)
Furnish, M.D., Dynamic compression and release experiments on Indiana limestone, 14:48164 (R;US)
Fursa, E.Ya., *See* Linev, V.N., 14:47844

G

Gabano, J.D., Experimental simulation of engine knock by means of a preheated static combustion chamber, 14:47301 (BA;US)
Gaddy, J.L., *See* Clausen, E.C., 14:46800
Gadomski, A.M., Mathematical model for real-time diagnostics of TRIGA RC-1 system, 14:47111 (R;IT)
Gaffney, E.S., Reaction kinetics and hydrogen generation, 14:47902 (RA;US)
See Brown, J.A., 14:47910
Gagliardi, C.A., Photon detector for MEGA: Progress report, July 15, 1988–May 1, 1989, 14:47824 (R;US)
Gaillard, F., *See* Chakir, A., 14:47617
Gale, J.G., Seismic analysis of the EBR-II [Experimental Breeder Reactor-II] containment structure, 14:47133 (R;US)
Galeev, A.M., ESR study of Mo(5) complexes with phosphorus- and arsenic-containing ligands, 14:47493 (RA;SU;In Russian)
Galeeva, S.I., *See* Galeev, A.M., 14:47493
Galimov, R.M., Static and dynamic characteristics of cerium ion in ethylsulfates under high pressure, 14:47487 (RA;SU;In Russian)
Galkina, S.A., *See* D'yachkova, T.A., 14:47521
Galyametdinov, Yu.G., *See* Galimov, R.M., 14:47487
Ganchev, A.H., *See* Dobrev, V.K., 14:48389
Gann, V.V., *See* Tolstolutskaya, G.D., 14:47369
Gant, R.E., *See* Teichert, W.P., 14:47216
Garate, E.P., High-gain plasma Cerenkov Maser, 14:48665 (J;US)
Garbincius, P., *See* Stefanski, R., 14:47784
Garcia, I.A., *See* Paisley, D.L., 14:47846
Garcia, M.N., Photogrammetric method for determining sink volumes at the Nevada Test Site, 14:47913 (RA;US)
Gardiner, W.C., *See* Frenklach, M., 14:46918
Gardner, D.G., Detailed photonuclear cross-section calculations and astrophysical applications, 14:48484 (R;US)
Gardner, M.A., *See* Gardner, D.G., 14:48484
Gardner, R.H., [SCOPE workshop on Landscape boundaries: Consequences for biotic diversity and ecological flows]: Foreign trip report, December 12–15, 1988, 14:47976 (R;US)
[Uncertainties of environment models in public health and environmental protection]: Foreign trip report, March 3–10, 1989, 14:48117 (R;US)
Garland, R., *See* Robertson, A., 14:47074
Garland, S.B. II, An evaluation of the use of a combination of ozone, ultraviolet radiation, and hydrogen peroxide to remove chlorinated hydrocarbons from groundwater at the Department of Energy Kansas City Plant: Fiscal year 1988, annual report, 14:48026 (R;US)
Garman, E.F., *See* Vermeer, W.J., 14:48443
Garnovskij, A.D., *See* Dorokhova, N.I., 14:47488
Garofalini, S.H., *See* Levine, S.M., 14:47453
Garvin, J.B., Geological remote sensing signatures of terrestrial impact craters, 14:48197 (RA;US)
Gary, S.P., Computer simulations of electromagnetic ion instabilities in the plasma sheet boundary layer, 14:48241 (R;US)
See Winske, D., 14:48242
Gasser, I., Many-point meson greens functions in the strong-coupling limit of the lattice quantum chromodynamics, 14:48345 (RA;AT;In German)
Gat, U., [Discussion of plastic media blasting]: Foreign trip report, 1988, 14:47289 (R;US)
Gatterer, K., *See* Gruber, H., 14:47426
Gaudern, S.L., *See* Sandalls, F.J., 14:47988
Gauld, D.W., *See* Gibbs, B.M., 14:46875
Gavrin, V.N., The Baksan gallium solar neutrino experiment, 14:48318 (R;US)
Gayen, S.K., *See* Petricevic, V., 14:47745
Gayevsky, V.I., *See* Gavrin, V.N., 14:48318
Geinzer, J., *See* Ford, A., 14:47080
Geiser, U., *See* Williams, J.M., 14:47347
Gell, G., PACS image archiving and -communication in radiology, 14:48104 (RA;AT;In German)
Generoso, W.M., [Short-term assays for detecting environmental mutagens, carcinogens, and teratogens]: Foreign trip report, February 4–28, 1989, 14:48145 (R;US)
Geng, L., Chemical phenomena in solid-state voltammetry in polymer solvents, 14:47535 (J;US)
Gentry, M.J., *See* Voorhees, L.D., 14:46999
Gepp, R.T., *See* Meyer, H.G., 14:48085
Gerard, G.J., *See* Lackey, W.J., 14:47408
Geretschlaeger, M., *See* Goiser, R., 14:47828
Gerhard, M.A., *See* Bumpus, S.E., 14:47729
Gerhardt, P., The formation of polyhedral carbon ions in fuel-rich acetylene and benzene flames, 14:47571 (BA;US)
Gering, T., *See* Blaser, P., 14:47071
Gerstenmayer, E., Quark confinement in supersymmetric QCD, 14:48344 (RA;AT;In German)
Gesalman, C.M., Guidelines and requirements for applying for grants from the Indian set-aside program, 14:48073 (R;US)
Gesztesy, F., *See* Bulla, W., 14:48565
Ghaffari, R., *See* Burgess, A.R., 14:46878
Ghassemi, M., In situ technologies for site remediation, 14:46986 (RA;US)
Ghirardi, G.C., Continuous spontaneous reduction model involving gravity, 14:48553 (R;XA)
Ghoniem, A.F., Origin and manifestation of flow-combustion interactions in a premixed shear layer, 14:47595 (BA;US)
Giacomini, J.C., *See* Thompson, A.C., 14:47459
Gibbard, J.R., *See* Dunlop, J.A., 14:47555
Gibbs, B.M., The reduction of NO_x emissions from a fluidized bed combustor by staged combustion combined with ammonia addition, 14:46875 (BA;US)
Gier, T.E., *See* Eddy, M.M., 14:47529
Giese, W., Radiocesium binding substances in livestock production, 14:48122 (R;DE;In German)
Gill, S.M., *See* Welch, K.M., 14:47801, 14:47804
Gillespie, A., *See* Brown, S., 14:47035
Gillette, G.L., *See* Collins, B.L., 14:47273
Ginley, D.S., *See* Venturini, E.L., 14:47404
Ginzburg, I.F., Two-photon physics at LEP, 14:48352 (RA;SU)
Girin, S.V., *See* Gavrin, V.N., 14:48318

Givi, P., Direct numerical simulations of a two-dimensional reacting, spatially developing mixing layer by a spectral-element method, 14:47593 (BA;US)
Glass, G., *See* Shimizu, H., 14:48295
Glassley, W.E., Computer modeling of the aqueous geochemistry of the Archean hydrosphere and the formation of banded iron formations, 14:48169 (RA;US)
Glassman, I., Soot formation in combustion processes, 14:47561 (BA;US)
See Hura, H.S., 14:47568
See Lovell, A.B., 14:47634
Glebov, A.N., *See* D'yachkova, T.A., 14:47521
Gleichmann, R., *See* Kalejs, J.P., 14:47456
Goddard, J.G., [Collection of North Pacific Ocean surface seawater samples from a container ship]: Foreign trip report, January 24–March 4, 1989, 14:47931 (R;US)
[Collection of North Pacific Ocean surface seawater samples for chemical analysis]: Foreign trip report, January 26–February 27, 1988, 14:48022 (R;US)
Godfrey, B.B., *See* Wagner, J.S., 14:47798
Goekalp, I., *See* Boukhalfa, A., 14:47605
Goforth, J.H., *See* Lindemuth, I.R., 14:47766
Goiser, R., LISA, a time-of-flight spectrometer for measurements of stopping cross sections, 14:47828 (RA;AT;In German)
Gokalp, I., Observations on the low temperature vaporization and envelope or wake flame burning of n-heptane droplets at reduced gravity during parabolic flights, 14:47710 (BA;US)
Gokcay, C.F., *See* Yurteri, R., 14:46808
Gold, S.H., Gyroklystron device having multi-slot bunching cavities, 14:47772 (P;US)
Golden, D.M., *See* Steward, P.H., 14:47624
Golden, D.W., Investigation of reactor coolant system depressurization as an accident management strategy, 14:47136 (R;US)
Summary of the results of the TMI-2 analysis exercise, 14:47168 (J;US)
Goldsmith, J.E.M., Multiphoton-excited fluorescence measurements of atomic hydrogen in low-pressure flames, 14:47660 (BA;US)
Goldsmith, W., *See* Caldwell, J.T., 14:46937
Goldsmith, W.A., *See* Allen, D.F., 14:46936
Goldstein, D.A., Study of structure-function relationships in proteins: Techniques and applications ot cytochrome c: Final report January 15, 1988–January 14, 1989, 14:48087 (R;US)
Golovashkin, A.I., Optical properties of superconducting metal oxide ceramics, 14:47394 (RA;SU;In Russian)
Golovin, K.A., *See* Miroshnichenko, I.V., 14:47492
Golubov, S.I., Estimation of drift intensities of point defects based on recombination process, 14:47360 (RA;SU;In Russian)
Gomez, C.C., *See* Kyrala, G.A., 14:48273
Gonard, T., *See* Finkbeiner, F., 14:47281
Goncharenko, Yu.D., *See* Pecherin, A.M., 14:47364
Good, B.A, TMI [Three Mile Island] and the environment, 14:47172 (J;US)
Good, B.A., *See* Lodde, G.M., 14:47183
Goodfellow, W.L., *See* Botts, J.A., 14:48045
Goodman, J.A., *See* Haines, T.J., 14:48183
Goodner, J.F., *See* Carlson, R.L., 14:47226
Goodwin, P.M., *See* Cool, T.A., 14:47462
Gordon, B.M., The application of synchrotron radiation to microprobe trace element analysis of biological samples, 14:47461 (R;US)
Gordon, H.J., *See* Thompson, A.C., 14:47459
Gordon, T., *See* Sheppard, D., 14:48147
Gore, J.P., *See* Kounalakis, M.E., 14:47649
Gorishny, S.G., Behaviour of σ_{tot} (e^+e^-->hadrons) in QCD and in theories with scalar quarks, 14:48351 (RA;SU)
Gorney, D.J., *See* Ahn, B., 14:48234
Gornik, E., *See* Strasser, G., 14:47427
Goshaw, A.T., *See* Fortney, L.R., 14:48289
Goss, L.P., *See* Chen, L.D., 14:47596
See Vilimpoc, V., 14:47702
Gossett, C.A., The University of Washington polarized ion source, 14:47805 (R;US)
Gouldin, F.C., Experimental evaluation of the fractal geometry of flamelets, 14:47583 (BA;US)
Goulding, F., *See* Silver, E., 14:47850
Goussis, D.A., *See* Lam, S.H., 14:47623
Gower, G.L., *See* Connell, J.R., 14:47073
Goyal, G., *See* Lakshmisha, K.N., 14:47676
Grabowski, K.S., *See* King, W.E., 14:47384
Gracia-Salcedo, C.M., *See* Brabbs, T.A., 14:46903
Gradie, J.C., Spectral reflectance characteristics of clay-bearing soils: Applications to downhole environments, 14:47898 (RA;US)
Grady, K.A., *See* Wicke, B.G., 14:47575
Graessle, S., *See* Dyer, P., 14:48359
Graff, R.A., Steam conditioning of coal for synfuels production: Final report, 14:46817 (R;US)
Graham, R.A., *See* Reed, R.P., 14:47444
See Venturini, E.L., 14:47404
Grambow, B., Thermodynamic and kinetic modeling of glass leaching in a waste package environment, 14:46962 (RA;US)
Graninger, W., *See* Kallinger, W., 14:48126
Grant, N.J., Liquid Dynamic Campaction of Fe-Nd-B permanent magnets. Final report, 1 September 1984-31 December 1988, 14:47327 (R;US)
Grassi, R., *See* Ghirardi, G.C., 14:48553
Gratton, J., Non Newtonian gravity creeping flow, 14:48499 (R;XA)
Gray, G.T. III, *See* Morris, C.E., 14:47433
Gray, R.H., Environmental monitoring at the US Department of Energy's Hanford Site, Washington, 14:47990 (RA;US)
Gray, W.J., Leaching of ^{14}C and ^{36}Cl from irradiated French graphite, 14:46978 (R;US)
Green, L., *See* Erskine, D.J., 14:47863
Green, R.M, *See* Schipperijn, F.W., 14:47309
Green, S., *See* Rimer, N., 14:47888
Green, S.J., *See* Lupo, J.F., 14:47887
Greenberg, A.J., *See* Fessler, R.G., 14:46992
Greene, G., *See* Burson, S.B., 14:47164
Greengard, T.C., *See* Anderson, M.A., 14:46991
Greenwood, Z., *See* Baumann, N., 14:48304
Greer, J.T., Electron beam welding: Model of high voltage bias transmission line and termination circuits, 14:47377 (R;US)
Gregory, D.C., [Electron-impact ionization, Giessen, W. Germany, and visit to Darmstadt, W. Germany, February 28–March 12, 1988]: Foreign trip report, 14:48275 (R;US)
Greig, D.R., *See* Chan, C.K., 14:47690
Greiner, N.R., KIVA reactive hydrodynamics code applied to detonations in high vacuum, 14:47857 (R;US)
Grest, G.S., *See* Anderson, M.P., 14:48537
Gribanov, Yu.A., *See* Volkov, E.D., 14:47368
Griest, K., *See* Deluca, E.E., 14:48189
Grieve, R.A.F., *See* Garvin, J.B., 14:48197
Griffin, K.L., *See* Druce, R.L., 14:47727
Griffiths, J.F., Oscillatory combustion in closed vessels: Theoretical foundations and their experimental verification, 14:47679 (BA;US)
Griffiths, S.K., Similarity analysis of condensing flow in a fluid driven fracture, 14:47875 (RA;US)
Grigsby, R.D., *See* Thomson, J.S., 14:46836
Grindley, T, Method for enhancing the desulfurization of hot coal gas in a fluid-bed coal gasifier, 14:46831 (P;US)
Grinstein, B., Charge quantization of wormholes and the finiteness of Newton's constant, 14:48580 (J;NL)
Grishechkina, S.P., Change of p-n junction photoelectric properties during semiconductor transition in to ferroelectric phase, 14:48514 (RA;SU;In Russian)
Grisogono, A.M., Orbital momentum distributions and binding energies for the complete valence shell of molecular iodine, 14:48254 (R;AU)
See Frost, L., 14:48249, 14:48252
Grobstein, T.L., Creep behavior of tungsten fiber reinforced niobium metal matrix composites, 14:47351 (R;US)
Grosjean, D., *See* Williams, E.L., 14:47941
Gross, F., *See* Hohenau, W., 14:47826
Gross, M., Plasma etching of photoresist materials for microelectronic applications, 14:48506 (RA;AU)
Grossbeck, M.L., Tensile behavior of helium-implanted and neutron-irradiated V-15 Cr-5 Ti, 14:48697 (J;US)
Grosshandler, W.L., *See* Fischer, S.J., 14:47646
Grosskopf, P.P., *See* Duke, J.C. Jr., 14:47440

Grotheer, H.H., Reactions of hydroxymethyl and hydroxyethyl radicals with molecular and atomic oxygen, 14:47626 (BA;US)
Gruber, E., *See* Brand, M., 14:47255
Gruber, H., Influence of doping with Sb, Pb and Ag in the high-temperature superconductor systems Bi-Sr-Ca-Cu-O and Tl-Ba-Ca-Cu-O, 14:47426 (RA;AT;In German)
Gruebl, G., *See* Embacher, G., 14:48405
See Embacher, H.G., 14:48406
Gruen, K., *See* Oberhummer, H., 14:48676
Gruending, F.J., *See* Brand, M., 14:47255
Gruetzmacher, K.M., *See* Yamanishi, T., 14:48700
Grundinger, U., GSI scientific report 1988, 14:48431 (R;DE)
Gu, C., *See* Arko, A.J., 14:48531
Guidry, F.K., Devonian shale-specific computation methodology. Topical report, June 1988, 14:46906 (R;US)
Guin, J.A., *See* Curtis, C.W., 14:46898
Guinton, M.F., *See* Legrand, A.P., 14:46837
Gulati, A., *See* Correa, S.M., 14:47589
Gulati, S., *See* Iyengar, S.S., 14:47295
Gulati, S.K., *See* Burmeister, M., 14:47636
Gumnick, J.L., University programs in waste management research, education, and training, 14:46989 (RA;US)
Gunasekaran, M., Microbial solubilization of peat for production of synthetic fuels, 14:46805 (RA;US)
Gunn, D., Summary of findings on evaluation of aqueous degreasers versus chlorinated solvents at the Paducah Gaseous Diffusion Plant, 14:46940 (RA;US)
Gunther, W., *See* Hall, R.E., 14:47163
Gupta, A., Parallel implementation of OPS5 on the Encore multiprocessor: Results and analysis, 14:48714 (R;US)
Suitability of message-passing computers for implementing production systems, 14:48715 (R;US)
See Agarwal, A., 14:48713
Gupta, R.K., *See* Gupta, S.K., 14:48468
Gupta, S.K., Theoretical study of cold nuclear fusion using barrier penetration approach, 14:48468 (R;XA)
Gupta, S.L., *See* Dracoulis, G.D., 14:48456
Gurr, H., *See* Baumann, N., 14:48304
Gusar, O.L., *See* Zajkin, Yu.A., 14:47366
Gutman, D., *See* Russell, J.J., 14:47920
See Slagle, I.R., 14:47625
Gutmark, E., Evolution of vortical structures in flames, 14:47581 (BA;US)
Guzik, J.A., Effects of main-sequence mass loss on the turnoff ages of population 1 clusters, 14:48185 (R;US)
Effects of main-sequence mass loss on the turnoff ages of globular clusters, 14:48186 (R;US)
Guzman, E., *See* Atallah, S., 14:46911
Gvildys, J., *See* Wang, C.Y., 14:47132
Gyapong, G.J., *See* Burnett, S.M., 14:48451
Gyulassy, M., *See* Padula, S.S., 14:48486

H

Habegger, L.J., *See* Martino, L.E., 14:47214
Haberer, K., Environmental radioactivity and water supply. Pt. 3. The contamination of surface waters in Germany after the Chernobyl reactor accident, 14:47127 (R;FR;In French)
Hack, W., *See* Baetz, P., 14:47639
Hackel, R.P., *See* Bass, I.L., 14:47748
Hackenburg, R.W., *See* Love, W.A., 14:47839
Hackworth, J.H., Fuel cells application in the industrial sector: Task 15, Final report, 14:47284 (R;US)
Haddad, G.I., *See* Mains, R.K., 14:47762
Haenni, H., Search for monojet and multijet events with large missing P_T in the UA2 experiment, 14:48302 (RA;PL)
Hafer, J.F., *See* Stirpe, D., 14:46928
Hager, E.R, *See* Fisher, M.V., 14:48705
Hager, E.R., *See* Tabor, M.A., 14:48704
Hahkala, M., *See* Kauppinen, E., 14:47778
Hahn, S., *See* Stein, H.J., 14:48522
Hahon, N., Polycyclic aromatic hydrocarbons, particulates, and defense mechanisms (VKC-BAB-145). Final report, 14:47945 (R;US)
Haines, T.J., The status of CYGNUS experiment: Past, present, and future, 14:48183 (R;US)
Hair, L.M., *See* Droege, M.W., 14:47018, 14:47019
Halbert, M.L., [Heavy ion physics]: Foreign trip report, July 17, 1988–August 4, 1988, 14:48481 (R;US)
Halda, E., *See* Nilson, R., 14:47876
See Rimer, N., 14:47871
Halda, E.J., *See* Rimer, N., 14:47874
Hall, L.J., Supersymmetric flavor and CP violation, 14:48361 (RA;PL)
Hall, M.J., *See* Witze, P.O., 14:47310
Hall, R.E., Managing the effects of aging and reliability improvement, 14:47163 (J;NL)
Hamada, Kenji, Parametrization of super light-cone diagrams with g-loops., 14:48412 (RA;JP)
Hamberger, S.M., Great stellarator revival, 14:48681 (RA;AU)
See Conway, G.D., 14:48593
See Shi, X.H., 14:48626
Hammack, W.S., Pressure-induced spin-state interconversion of $(Fe(6\text{-}Me\text{-}py)_3tren)(ClO_4)_2$ in solution, 14:47527 (J;US)
Hammer, D.A., Generation and focusing of pulsed intense ion beams: Final report, 1 July 1987–30 September 1988, 14:48671 (R;US)
Hammer, J.A., *See* Miake-Lye, R.C., 14:47612
Hamzaoui, C., *See* Boudjema, F., 14:48325
Han, K.S., Direct solar-pumped iodine laser amplifier. Semiannual progress report, 1 September 1988-28 February 1989, 14:47746 (R;US)
Handl, O., *See* Handl-Zeller, L., 14:48108
Handl-Zeller, L., Simultaneous application of irradiation and hyperthermia for tumor therapy, 14:48108 (RA;AT;In German)
Haneda, Noriyuki, *See* Nakamura, Yoshiteru, 14:47015
Hanigofsky, J.A., *See* Lackey, W.J., 14:47408
Hanley, H.J.M., Prediction of shear viscosity and non-Newtonian behavior in the soft-sphere liquid, 14:47526 (J;US)
Hanna, F., *See* Wright, L.L., 14:47030
Hanna, M.L., Radioactive-electrophoretic assay of adenosine 5'-triphosphate sulfurylase activity in crude extracts with sulfate or selenate as a substrate, 14:48095 (J;US)
Hansen, L.F., *See* Namboodiri, M.N., 14:48460
Hansen, O., Strangeness production in Si + Au interactions at 14.6 GeV/c per nucleon, 14:48293 (R;US)
Hanson, A.L., *See* Gordon, B.M., 14:47461
Hanson, J.M., *See* Burkhard, N.R., 14:47904
Hanson, M.E., *See* Mavko, B.B., 14:46913
Hanson, R.K., *See* Davidson, D.F., 14:47538
Harada, Hiroo, *See* Nonomiya, Iwao, 14:47104
Harding, L.B., Theoretical study of the reactions rates of OH + OH $\Longleftrightarrow$ H_2O + O, 14:47628 (BA;US)
See Dunning, T.H. Jr., 14:47262
Hargrave, G.K., *See* Birch, A.D., 14:47613
Harjes, H.C., *See* Vandevender, J.P., 14:48692
Harkleroad, M., *See* McCaffrey, B.J., 14:46902
Harmon, A., *See* Namboodiri, M.N., 14:48460
Harper, G.C., *See* Gossett, C.A., 14:47805
Harrach, R.J., High pressure, energy, and impulse loading of the wall in a 1-GJ Laboratory Microfusion Facility, 14:48696 (R;US)
Harris, J.N., *See* Starr, T.L., 14:47401
Harris, M.M., *See* Bourqeois, B.S., 14:48717
Harris, R.T., *See* Martz, D.E., 14:48140
Harris, S.J., A picture of soot particle inception, 14:47564 (BA;US)
Harrison, C.W., *See* Guidry, F.K., 14:46906
Harrison, T.M., *See* Koeberl, C., 14:48199
Harrje, D.T., Diagnostic approaches to better solutions of radon IAQ (indoor air quality) problems, 14:47962 (R;US)
Harsh, D., Slurry concentration and mesh size in the development of microbial coal desulfurization, 14:46807 (RA;US)
Hartman, F.C., Examination of the function of active site lysine 329 of ribulose-bisphosphate carboxylase/oxygenase as revealed by the proton exchange reaction, 14:48096 (J;US)
[Function of active-site residues of ribulosebisphosphate carboxylase/oxygenase, Stockholm, Sweden, and visit to Uppsala,

Sweden, August 6–12, 1989]: Foreign trip report, 14:47037 (R;US)
Harvey, J.A., Measurement of total neutron cross-sections for determination of the electric polarizability of the neutron, 14:48315 (RA;AT;In German)
Hasbrouck, R.T., Performance of transient limiters under laboratory, simulated, and rocket-triggered lightning conditions, 14:47769 (R;US)
Hasegawa, Kazuo, Detector system for gamma-ray production cross section measurements and data analysis, 14:47829 (R;JP;In Japanese)
Hashimoto, Kazuichiro, *See* Nishio, Gunji, 14:46932
Hassan, M.Y.M., *See* Tag Eldin, I.M.A., 14:48467
Hassler, T.J., *See* Fritzsche, R.A., 14:48016
Hasson, A., *See* Segev, G., 14:47692
Hatcher, H.J., *See* Quigley, D.R., 14:46803
Hathaway, J.R., *See* Wardwell, R.E., 14:47217
Hattrup, M.P., Commercialization of aquifer thermal energy storage technology, 14:47202 (R;US)
Hauer, J.F., *See* Smith, J.R., 14:47077
Hauser, R., *See* Hilscher, G., 14:47357
Haussmann, G.J., Rapid pyrolysis and combustion of pulverized Montana Rosebud subbituminous coal, 14:46864 (BA;US)
Hautman, N., Response of the US EPA (Environmental Protection Agency) region 5 states to the nonpoint source reporting requirements of the 1987 Clean Water Act amendments. Technical report, 14:48056 (R;US)
Havela, L., *See* Pillmayr, N., 14:47353
Havener, C.C., [Physics of multicharged ions]: Foreign trip report, September 12–23, 1988, 14:48276 (R;US)
Hawke, R.S., *See* Cutting, J.L., 14:47768
Hawkins, K.D., *See* Dickson, F.J., 14:47554
Hawkins, W.L., Borehole inspection system for large diameter holes, 14:47891 (RA;US)
Geologic and hydrologic investigations at the ALEMAN (U3KZ) site, and other sites in Yucca Flat, the Nevada Test Site, 14:47909 (RA;US)
Hawliczek, R., Brachytherapy with I-125: a novel implantation system, 14:48109 (RA;AT;In German)
See Schmidt, W., 14:47808
Haworth, D.C., The importance of time-dependent flame structures in stretched laminar flamelet models for turbulent jet diffusion flames, 14:47588 (BA;US)
Hay, P.J., *See* Eberhardt, J., 14:47380
Hayakawa, S., *See* Deeter, J.E., 14:48187
Hayba, D.O., *See* Plumlee, G.S., 14:47059
Haydon, S.C., RF plasmas and impurity effects, 14:48623 (RA;AU)
See Ernest, A.D., 14:48267, 14:48600
Haynam, C.A., *See* Bass, I.L., 14:47748
Haynes, H.D., Aging and service wear of electric motor-operated valves used in engineered safety-feature systems of nuclear power plants: Aging assessments and monitoring method evaluations, 14:47147 (R;US)
Haynes, T.E., [Ion beam deposition of epitaxial germanium and gallium arsenide layers]: Foreign trip report, June 2, 1989–June 18, 1989, 14:48521 (R;US)
He, X.G., *See* Babu, K.S., 14:48358
Heagle, A.S., Injury and yield response of cotton to chronic doses of ozone and soil-moisture deficit, 14:48153 (R;US)
Heap, M.P., *See* Chen, S.L., 14:46874
Hearst, J.R., Measurement of in situ strength using projectile penetration: Tests of a new launching system, 14:47897 (RA;US)
See Burkhard, N.R., 14:47904
Heck, W.W., *See* Heagle, A.S., 14:48153
Heelis, R.A., *See* Anderson, D.N., 14:48233
Hegde, U.G., *See* Sankar, S.V., 14:47658
Heikkinen, D.W., *See* Pontau, A.E., 14:47480
Heim, J.R., *See* Summers, L.T., 14:48695
Heim, U., *See* Schreiber, E., 14:47268
Heindler, M., D-^{3}He as fusion fuel, 14:48679 (RA;AT;In German)
Heiskanen, M., *See* Kauppinen, E., 14:47778
Heisler, S.W. Jr., *See* Mihalovich, G.S., 14:46957
Heitbrink, W.A., *See* Cooper, T.C., 14:47942
Heitzenroeder, P., *See* Loesser, G. D., 14:48703
Helble, J.J., *See* Kang, S.G., 14:46865
Held, K., *See* Zirps, N.A., 14:47215
Hendricks, M.S., *See* Walton, B.T., 14:48143
Hendrickson, D.N., *See* Hammack, W.S., 14:47527
Hendrikse, W.L.J., *See* Thomas, H., 14:48111
Henneke, E.G. II, *See* Duke, J.C. Jr., 14:47440
Henriksen, K., Weak homogeneous burning in front of a carbon surface, 14:46848 (BA;US)
Hensen, J.L.M., Outcome of 1988 work-stay at the University of Strathclyde in Glasgow, Scotland, 14:47267 (R;NL)
Hensler, E., *See* Schoepf, K., 14:48592
Henson, J.M., *See* Cochran, J.W., 14:48031
Hepler, W.A., Numerical simulation study of a hydrazine/nitrogen dioxide diffusion flame in a Burke-Schumann burner, 14:47696 (BA;US)
Herbert, A.W., Matrix diffusion user guide (release 2), 14:47987 (R;GB)
Hercules, D.M., Studies of supported hydrodesulfurization catalysts: Progress report for period January 1, 1989–December 31, 1989, 14:47484 (R;US)
Hering, S.V., Nitric acid shootout: field comparison of measurement methods (journal version), 14:47937 (R;US)
Herman, F., Discussion of theoretical techniques in quantum chemistry and solid state physics, 14:47326 (RA;US)
Herman, J.S., Modeling mass transfer reaction rates: Calcite precipitation and CO_2 outgassing in a Karst steam, 14:47064 (RA;US)
Hermann, H., *See* Laschka, D., 14:47125
Herndl, H., *See* Bach, B., 14:48677
Hertzberg, M., *See* Cashdollar, K.L., 14:46842
Hess, J.W., *See* Pohlmann, K.F., 14:48032
Hesse, D., *See* Boehm, H., 14:47572
Hetsroni, G., *See* Banerjee, S., 14:47100
Hewel-Bundermann, H., Studies on the water uptake capacity and pore structure of coal with a view to rock burst prevention, 14:46834 (R;DE;In German)
Heyd, A.R., *See* Ravindra, N.M., 14:47406
Heywood, J.B., *See* Chun, Kwang Min, 14:47302
Hidekuma, S., *See* Taniguchi, Y., 14:48685
Hiebert, J.C., *See* Shimizu, H., 14:48295
Higgins, G.H., Shock vaporization and melting of saturated tuff, 14:47889 (RA;US)
Higley, K.A., Use of a Monte Carlo modeling approach for evaluating risk and environmental compliance, 14:47220 (RA;US)
Higuchi, Suminori., *See* Oikawa, Testukuni, 14:47106
Hikawa, Michihiro, *See* Oikawa, Testukuni, 14:47106
Hildebrand, A.R., Provenance of the K/T boundary layers, 14:48198 (RA;US)
Hildebrand, J.E., Personnel contamination protection techniques applied during the TMI-2 [Three Mile Island Unit 2] cleanup, 14:47182 (J;US)
Hildebrand, S.G., [Case studies examining energy policies and strategies for water resources development]: Foreign trip report, May 7–13, 1989, 14:48013 (R;US)
Hill, N.W., *See* Harvey, J.A., 14:48315
Hill, P.C., Federalism and the surface-water program. Technical report, 14:48059 (R;US)
Hille, P., *See* Bettinger, D., 14:47428
See Wallner, G., 14:47473
See Wergles, K., 14:47474
Hillis, S.L, *See* McGill, R.N., 14:47028
Hills, M.M., *See* Lince, J.R., 14:48495
Hilscher, G., Spin fluctuations and weak itinerant ferromagnetism in $Y(Co_{1-x}Al_x)_2$ $(0,00 \leq x \leq 0,18)$, 14:47357 (RA;AT;In German)
Superconductivity and magnetic order in $Y_{1-x}Pr_xBa_2Cu_3O_7$, 14:47425 (RA;AT;In German)
See Pillmayr, N., 14:47353
See Wiesinger, G., 14:47356
Hilton, S.M., *See* Gouldin, F.C., 14:47583
Himme, B., *See* Bley, U., 14:47537
Hippchen, T., A consistent meson-theoretical model of the nucleon-antinucleon interaction, 14:48356 (R;DE;In German)
Hiramatsu, S., *See* Shimizu, H., 14:48295
Hirano, Masashi, *See* Watanabe, Tadashi, 14:47751
Hirano, Toshisuke, *See* Takeno, Keiji, 14:46922

Hirao, Toshio, *See* Nakamura, Yoshiteru, 14:47015
Hirata, Kazuo and others, *See* Kumamaru, Hiroshige, 14:47095
Hirata, S., *See* Yamanishi, T., 14:48700
Hirshfeld, A.C., Superspace quantization of gauge theories: gauge-fixing and ghost terms in N=1 supergravity, 14:48402 (RA;PL)
Hirvonen, R., Transient phenomena in asynchronous motor drive, 14:47082 (R;FI;In Finnish)
Hiyama, Tadao, *See* Yamamura, Hidemasa, 14:48687
Hjalmarson, H.P., *See* Tigges, C.P., 14:48523
Ho, J., Use of analytical models to characterize contaminant exposures in aquifers with limited field data, 14:48020 (RA;US)
Hodges, J.A., Rare earth Moessbauer absorption in $ErPd_2Sn$ and $YbPd_2Sn$, 14:47333 (R;FR)
See Bonville, P., 14:47332
Hoegler, J.M., *See* Wichner, R.P., 14:46976
Hoeppel, R.E., *See* Arthur, M.F., 14:47978
Hofer, W.W., *See* Druce, R.L., 14:47727
Hoff, R.W., *See* Gardner, D.G., 14:48484
Hoffman, C.M., *See* Haines, T.J., 14:48183
Hoffman, F.O., [Biospheric Model Validation Study (BIOMOVS) and the revision of IAEA safety series No. 57]: Foreign trip report, November 7–23, 1988, 14:47994 (R;US)
Hoffman, R.L., The determination of bioaccumulation in edible species from radioactive contamination at the Weldon Spring Site, St. Charles, Missouri, 14:47989 (RA;US)
Hoffman, Yehuda, Dynamics of superclusters - reconciling Omega(0) = 1.0 with observations?, 14:48229 (J;US)
Hoffmann, G., Studies of the conversion-chemistry of plutonium and uranium in the nitrate- and carbonate-systems. Final report, 14:47548 (R;DE;In German)
Hoffmann, M.R., Fog, cloud, and dew chemistry. Final report, 14:47940 (R;US)
Short-term trends and spatial variability in precipitation chemistry in the South Coast Air Basin. Final report, 14:47934 (R;US)
Hofstadter, R., *See* Thompson, A.C., 14:47459
Hohenau, W., Quartz resonator as radiation detector and energy dosimeter, 14:47826 (RA;AT;In German)
Holappa, K., Use of surface peat in growing media for landscaping and public gardens in Northern Finland, 14:47039 (R;FI;In Finnish)
See Eijaervi, E., 14:47038
Holcomb, R.S., [Combustion tests of sample Jordan oil shale, Karhula, Finland, and visit to Espoo, Finland, January 14–20, 1988]: Foreign trip report, 14:46921 (R;US)
Holl, B., Correlated particle production in proton-antiproton interactions at c.m. energies from 200 to 900 GeV, 14:48294 (R;DE;In German)
Holladay, S.K., *See* Maskarinec, M.P., 14:48029
Hollis, D.J., A detailed calculation of the collapse of the Misty Rain extension, 14:47870 (RA;US)
Holmberg, E., Target-specific binding of immunoliposomes in vivo, 14:48101 (R;US)
Holmes, S., *See* Stefanski, R., 14:47784
Holt, J.A., *See* Shimizu, H., 14:48295
Holzleithner, K., *See* Yoshio, M., 14:47206
Holzscheiter, M.H., *See* Dyer, P., 14:48359
Homann, K.H., *See* Gerhardt, P., 14:47571
Hones, E.W., *See* Singer, H.J., 14:48236
Hook, L.A., *See* Voorhees, L.D., 14:46999
Hoopes, B.L., The Multimedia environmental pollutant assessment system (MEPAS) user-friendly shell, 14:46993 (RA;US)
Hoover, D.L., High fluid levels in drill holes, Yucca Flat, Nevada Test Site, 14:47907 (RA;US)
Hoover, W.G., Fracture and flow via nonequilibrium molecular dynamics, 14:48280 (BA;US)
Horak, J.A., *See* Grossbeck, M.L., 14:48697
Horen, D.J., [A proposal for research to use the GANIL accelerator facility at Caen, France, May 30–31, 1988]: Foreign trip report, 14:48434 (R;US)
[Isoscalar quadrupole resonances in $^{90,96}Zr$ and $^{112,118,124}Sn$ by inelastic scattering of ^{17}O ions]: Foreign trip report, November 5–December 13, 1988, 14:48452 (R;US)
See Harvey, J.A., 14:48315
Hori, M., Nitrogen dioxide formation by the mixing of hot combustion gas with cold air, 14:47641 (BA;US)
Horne, T.E., *See* Petty, J.L., 14:47005
Horwitz, C.M., *See* Davies, K.E., 14:48503
See Gross, M., 14:48506
See Smith, A.M., 14:48504
Hosoya, Akio, (2+1)-dimensional pure gravity for an arbitrary closed initial surface, 14:48576 (R;JP)
Quantum gravity and cosmological constant, 14:48571 (RA;JP)
Hotchkis, M.A.C., *See* Orr, N.A., 14:48441
Hou Xiaoreng, *See* Zhang Jingzhong, 14:48542
House, J.W., *See* Brown, J.A., 14:47910
House, R.K., Matrix database of EPRI experimental projects on small-break loss-of-coolant accidents: Final report, 14:47137 (R;US)
Hovingh, J., *See* Bumpus, S.E., 14:47729
Howard, J., Linear systems description of forward scattering experiments, 14:48611 (RA;AU)
Multi-view scanning interferometer for the H-1 heliac, 14:48618 (RA;AU)
Tomography of soft X-ray emission on LT-4, 14:48628 (RA;AU)
See Sharp, L.E., 14:48617
Howard, J.B., *See* Ko, G.H., 14:46853
See Lam, F.W., 14:47563
Howard, S.C., *See* Bailey, J.K., 14:46938
Howe, M.A., *See* Weitkamp, W.G., 14:47806
Hoxie, C.L., *See* Hutchison, C.A., 14:46935
Hoyermann, K., *See* Bartels, M., 14:47632
Hozbor, M.A., *See* Evans, W.J., 14:47531
Hsu, B., *See* Leonard, G., 14:47305
Hsu, B.D., Progress on the investigation of coal-water-slurry fuel combustion in a medium-speed diesel engine, 14:47314 (BA;US)
Hu, N., *See* Chang, S.L., 14:47078
Huang, K., Triviality of the Higgs field, 14:48382 (J;US)
Huang, L., *See* Holmberg, E., 14:48101
Hubbard, L.M., *See* Harrje, D.T., 14:47962
Huber, M.L., *See* Hanley, H.J.M., 14:47526
Huber, T.F., *See* Bos, P., 14:46811
Hubmer, G.F., Kinetic boundary layer of the linearized Boltzmann equation at a partly absorbing sphere, 14:48260 (RA;AT;In German)
Hudgins, D., *See* Llave, F.M., 14:46892
Hudson, B., CORNUCOPIA cavity pressure measurement, 14:47900 (RA;US)
Hudson, J., Ontario Hydro training program for shipping radioactive materials, 14:46934 (RA;US)
Hudson, R.C., *See* Jennings, S.D., 14:47246
Huebel, K., *See* Laschka, D., 14:47125
Huebner, K., Report on the start-up of LEP, 14:47816 (RA;AT;In German)
Huebner, M.A., *See* Nichols, D.K., 14:47437
Hughes, M.A., Review of some aspects of the solution chemistry of technetium, 14:47481 (R;GB)
Hughes, W.T., *See* Drellack, S.L. Jr., 14:47892
Hull, A.P., Environmental measurements during the TMI-2 [Three Mile Island Unit 2] accident, 14:47171 (J;US)
Lessons learned from a review of post-accident sampling systems, high range effluent monitors and high concentration particulate iodine samplers, 14:47154 (BA;US)
Hull, L.C., *See* Van Deusen, L.C., 14:47003
Huneke, J.C., *See* Dunlop, J.A., 14:47555
Hungar, U., *See* Kenk, G., 14:48142
Huovinen, P., Service life assesment and examination of concrete structures in renovation, 14:47075 (R;FI;In Finnish)
Hura, H.S., Soot formation in diffusion flames of fuel/oxygen mixtures, 14:47568 (BA;US)
Hurley, K., *See* Schaefer, B.E., 14:48230
Hurst, J.K., Fundamental studies in charge separation at interfaces in relation to water photolysis: Progress report, January 15, 1987–June 25, 1989, 14:47483 (R;US)
Hutchison, C.A., French low-level waste characterization and certification, 14:46935 (RA;US)
Huys, D., *See* Regge, P. de, 14:47477
Hwang, I.H., *See* Han, K.S., 14:47746
Hyatt, M.J., *See* Bansal, N.P., 14:47396
Hyder, L.K., *See* Lee, S.Y., 14:46974

Hylton, T.D., Environmental studies in support of the live fire training facilities project, 14:48028 (R;US)
Hyman, J.A., *See* Nunno, T.J., 14:46994
Hymas, C.R., *See* Farnsworth, R.K., 14:46933
Hymer, J.D., *See* Struble, G.L., 14:47245

I

Ichimiya, A., *See* Ohtani, S., 14:48516
Ichinose, Shoichi, Two dimensional conformal gauge theories, 14:48414 (RA;JP)
Ida, K., Z_{eff} measurements and low-Z impurity transport for NBI and ICRF heated plasma in JIPP T-IIU tokamak, 14:48648 (R;JP)
Igashira, Masayuki, Measurements of gamma-ray production nuclear data of calcium and chromium, 14:48447 (R;JP;In Japanese)
Igrushin, V.V., Study of near-to-surface layers of α-Fe foil after Fe^{4+} ions irradiation and isochronous annealing, 14:47363 (RA;SU;In Russian)
Iinuma, K., *See* Kawakami, T., 14:47680
Ikalainen, B.H., *See* Wardwell, R.E., 14:47217
Ikegami, K., *See* Shimizu, H., 14:48295
Ikeshima, Yoshiaki, In-pile loop OWL-2 and irradiation tests done with it, 14:47118 (R;JP;In Japanese)
Ikuta, Kazunari., Resistivity of flame plasma in an electric field, 14:48649 (R;JP)
Ilin, L.A., Radiological consequences of the Chernobyl accident in the Soviet union and measures taken to mitigate their impact, 14:47128 (R;FR;In French)
Imada, K., Studies on glass support for DNA synthesis, 14:48093 (R;JP)
Imai, K., *See* Shimizu, H., 14:48295
Imamura, J.N., *See* Steiman-Cameron, T.Y., 14:48231
Imbert, P., *See* Bonville, P., 14:47332
Ingalls, R.L., X-ray and γ-ray spectroscopy of solids under pressure: Annual technical progress report, October 1988–October 1989, 14:47471 (R;US)
Ingersoll, D.T., DABL69: A broad-group neutron/photon cross-section library for defense nuclear applications, 14:48491 (R;US)
Inoue, S., *See* Yoshio, M., 14:47206
Ipatti, A., *See* Huovinen, P., 14:47075
Irwin, T.J., *See* Weitkamp, W.G., 14:47806
Isbister, J.D., *See* Wyza, R.E., 14:46801
Ishibashi, Nobuyuki, Boundary and crosscap states in conformal field theories, 14:48413 (RA;JP)
Four dimensional open superstring model, 14:48367 (RA;JP)
Ishikawa, T., *See* Matsushita, T., 14:47812
Ishino, S., Need for and requirements for neutron irradiation facility for fusion materials testing, 14:48669 (R;US)
Isoda, Hiroshi, *See* Yuasa, Saburo, 14:47683
Israel, Y.A., Modelling of radioactive fallout in the vicinity of Chernobyl nuclear power plant accident, 14:47126 (R;FR;In French)
Itoh, H., Spectroscopic and image intensified investigations of low temperature DC and RF plasma in N_2, 14:48603 (RA;AU)
Its, A.R., Correlation radius for one-dimensional impenetrable bosons, 14:48554 (R;XA)
Temperature correlators of the impenetrable Bose gas as an integrable system, 14:48559 (R;XA)
Ivakin, A.A., *See* Zolotukhina, L.V., 14:47491
Ivanov, M.S., *See* Zajkin, Yu.A., 14:47366
Ivanova, E.I., *See* Andreeva, S.G., 14:47550
Iwamoto, Satoshi, Records of radiation control division, 24 (1987), 14:48493 (R;JP;In Japanese)
Iyengar, S.S., Smelting networks for real time cooperative planning in the presence of uncertainties, 14:47295 (BA;US)
See Sabharwal, A., 14:48738
Izergin, A.G., *See* Its, A.R., 14:48554, 14:48559

J

Jabkhiro, E.H., *See* Delfosse, L., 14:47558
Jackson, J.N., *See* Bonvin, E., 14:48292
Jackson, K.J., *See* Glassley, W.E., 14:48169
Jackson, W.D., *See* Neimark, L.A., 14:47165
Jacobs, A., Measurements of absolute rate coefficients for the reactions of CN radicals with H_2O, H_2, and CO_2 in the temperature range 295 K $\leq$ T $\leq$ 1027 K, 14:47637 (BA;US)
Jacobs, G.K., *See* Spalding, B.P., 14:46952
Jacobson, K.B., [Regulation of tetrahydropterins in Drosophila: Research review]: Foreign trip report, April 5, 1989–May 5, 1989, 14:48091 (R;US)
Jaeger, H., Novel interferometric methods in plasma diagnostics, 14:48591 (RA;AT;In German)
Thermophysical investigations of tungsten at high temperatures and pressures, 14:47355 (RA;AT;In German)
Jaffe, P.R., Biodegradation of trichloroethylene and biomanipulation of aquifers. Technical report (Final), 14:48030 (R;US)
Jagannathan, S., Programming language supporting first-class parallel environments. Technical report, 14:48718 (R;US)
Jagoda, J.I., *See* Sankar, S.V., 14:47658
See Strahle, W.C., 14:47585
Jahn, R.K., Engine combustion optimization by exhaust analysis. Final report, December 1986-July 1988, 14:47307 (R;US)
James, B.W., *See* Bowden, M.D., 14:48616
See Studer, A., 14:48269
See Swift, P., 14:48270
See Turner, G.M., 14:48502
Jamison, J.D., Emergency environmental monitoring practices at U.S. nuclear power reactor sites, 14:47160 (BA;US)
Jander, H., *See* Boehm, H., 14:47572
Jander, S., *See* Rockwell, R.J., 14:47939
Janecky, D.R., Serpentinization reaction pathways: Implications for modeling approach, 14:47063 (RA;US)
Janke, P.J., *See* Chan, S.H., 14:47601
Jansohn, P., *See* Kolb, T., 14:46915
Janssen, P.A.E.M., Nonlinear effects in water waves, 14:48544 (R;XA)
Jantsch, W., *See* Bettinger, D., 14:47428
Jarosinski, J., Interaction of a vortex ring and a laminar flame, 14:47579 (BA;US)
See Pu, Yi Kang, 14:47694, 14:47695
Jedrzejek, C., Quantum model of thermal desorption and laser stimulated desorption, 14:47338 (RA;US)
Jeffery, J.J., Radium and heavy metal transport beneath an abandoned uranium tailings dam, 14:46984 (R;AU)
Jeffries, J.B., *See* Kohse-Hoeinghaus, K., 14:47465
Jehanno, C., *See* Rocchia, R., 14:48206
Jehanno, G., *See* Bonville, P., 14:47332
See Hodges, J.A., 14:47333
Jellison, J.L., *See* Russo, A.J., 14:47382
Jenkins, R.A., *See* Maskarinec, M.P., 14:48029
Jennings, S.D., Conversion of NE [nuclear energy] standards to national consensus standards, 14:47246 (R;US)
Jensen, K.M., *See* Leino, R.L., 14:48146
Jensen, R.H., Multiple endpoints for somatic mutations in humans provide complementary views for biodosimetry, genotoxicity, and health risks, 14:48094 (R;US)
Jensen, T.H., *See* Fisher, M.V., 14:48705
Jessup, J.S., *See* Pink, P.N., 14:48742
Jiang, Yanan, *See* Fiechtner, G.J., 14:47468
Jochem, E., *See* Brand, M., 14:47255
Jodlbauer, H., Complex susceptibility and magnetic properties of (Bi,Pb)SrCaCuO, 14:47390 (RA;AT;In German)
See Lang, W., 14:47391
See Markowitsch, W., 14:47424
Joerg, C.F., *See* Watkins, R.D., 14:47446
Johanson, E.S., *See* Comolli, A.G., 14:46821
Johnson, A.M., Hot-surface ignition tests of aircraft fluids. Final report, May 1987-May 1988, 14:46901 (R;US)
Johnson, D.L., *See* Vandevender, J.P., 14:48692
Johnson, D.W., *See* Lindberg, S.E., 14:47933
Johnson, J.D., Carbon in detonations, 14:47856 (R;US)
Johnson, J.L., *See* Miller, A., 14:48659
See Parker, R.D., 14:48584
Johnson, J.P., *See* Hasbrouck, R.T., 14:47769
Johnson, L.H., *See* Maskarinec, M.P., 14:48029

Johnson, N.R., [Collective properties of light tungsten and osmium nuclei]: Foreign trip report, July 24, 1988–July 29, 1988, 14:48480 (R;US)
Johnson, O.D., *See* Murphy, M.J., 14:46917
Johnson, R., Computer controlled MHD power consolidation and pulse-generation system: Progress report, October 1987–March 1988, 14:47257 (R;US)
Johnson, R.N., *See* Hsu, B.D., 14:47314
Johnson, W.J.D., A proposed linac cavity rf drive system for the Los Alamos extreme ultraviolet free-electron laser, 14:47786 (R;US)
See Stein, W.E., 14:47744
Johnston, R.G., Zeeman interferometry, 14:48271 (R;US)
Jones, D.T.L., Characteristics of Geiger-Mueller counters used in neutron dosimetry applications, 14:47832 (R;ZA)
See Thomas, H., 14:48111
Jones, E.D., Strain and density dependent valence-band masses in InGaAs/GaAs and GaAs/GaAsP strained-layer structures, 14:47447 (R;US)
Jones, G., *See* Eddy, M.M., 14:47529
Jones, G.J., *See* Post, H.N., 14:47040
Jones, I.R., Rotamak research 1987/88, 14:48594 (RA;AU)
See Besson, G., 14:48607
See Xu, S., 14:48620
Jones, J.P., Concurrent algorithms for a mobile robot vision system, 14:47770 (BA;US)
Jones, K.W., *See* Gordon, B.M., 14:47461
Jones, L.A., *See* Kyrala, G.A., 14:48273
Jones, L.S., *See* Bailey, J.K., 14:46938
Jones, M.E., A fully electromagnetic hybrid model for high density plasma simulations, 14:48655 (R;US)
See Mason, R.J., 14:47201
Jones, M.L., *See* McCollor, D.P., 14:46849
Jones, R.H., Camborne geothermal energy project 2C-7 resource evaluation. V. 2. Seismic reflection survey, 14:47054 (R;GB)
See Willis-Richards, J., 14:47053
Joost, S.F., *See* Stewart, R.C., 14:46975
Jorgenson, J.W., *See* Geng, L., 14:47535
Joshi, Chan, Wave particle interactions: Final report, November 6, 1987–October 31, 1988, 14:48661 (R;US)
Jou, W.H., *See* Givi, P., 14:47593
Joulain, P., *See* Bouhafid, A., 14:47650
Joulin, G., Radiation-dominated propagation and extinction of slow, particle-laden gaseous flames, 14:47677 (BA;US)
Judkins, R.R., Materials performance in coal gasification pilot plants, 14:46829 (BA;US)
Just, T., *See* Braun-Unkhoff, M., 14:47633
See Grotheer, H.H., 14:47626
See Meier, U., 14:47467
Justich, E., *See* Stollberger, R., 14:48107

K

Kageyama, T., *See* Gabano, J.D., 14:47301
Kahlert, H., *See* Abt, R., 14:47423
Kahr, G., *See* Rabitsch, H., 14:48127
Kailasanath, K., *See* Patnaik, G., 14:47671
Kainz, A., Structure of a boundary layer in a system of Brownian particles, 14:48261 (RA;AT;In German)
Kainz, W., *See* Gasser, I., 14:48345
Kakwani, R.M., Combustion characteristics of dry-coal-powder-fueled adiabatic diesel engine, 14:46884 (BA;US)
Kalb, H., *See* Brand, M., 14:47255
Kalejs, J.P., EBIC evidence for carbon-based gettering in EFG silicon, 14:47456 (BA;US)
Kalinichenko, A.M., *See* Derskij, L.S., 14:48511
Kalinichenko, N.B., Vanadium complexing with thiooxalates, 14:47495 (RA;SU;In Russian)
Kalinin, A.N., *See* Diasamidze, Eh.M., 14:47367
Kalinovskaya, I.V., *See* Karasev, V.E., 14:47509
Kalinowski, J., *See* Hudson, B., 14:47900
Kallinger, W., Effect of high radiation doses on human fetuses, 14:48126 (RA;AT;In German)
See Schachner, J., 14:48103
Kalp, D., *See* Gupta, A., 14:48714
Kamada, Yutaka, Confinement properties of pellet injected JT-60 plasmas, 14:48654 (R;JP)
Kamelander, G., Collective processes with energetic particles in fusion plasmas, 14:48590 (RA;AT;In German)
Kamide, Y., *See* Ahn, B., 14:48234
Kamo, R., *See* Kakwani, R.M., 14:46884
Kamp, G., Developing a programmatic approach to investigating and remediating many unrelated comprehensive environmental response, compensation and liability act sites at Kelly Air Force Base, 14:47218 (RA;US)
Kamyshnyj, A.L., *See* Sujsalu, A., 14:47500
Kandarjian, L., Federal policy options for indoor air pollution from combustion appliances. Technical report, 14:47968 (R;US)
Kaneko, Hirohisa, *See* Nakamura, Yoshiteru, 14:47015
Kaneko, O., *See* Ida, K., 14:48648
Kaneko, Toshiaki., Solid-vapor differences of electronic stopping powers for protons, 14:48517 (R;JP)
Kang, S.G., Time-resolved evolution of fly ash during pulverized coal combustion, 14:46865 (BA;US)
Kang, S.W., Particle rotation in coal combustion: Statistical, experimental and theoretical studies, 14:46856 (BA;US)
Kania, M.J., [High temperature fuel behavior, fission products, and graphite]: Foreign trip report, March 5–13, 1988, 14:47098 (R;US)
Kanithi, H.C., Fine filament NbTi conductors for the SSC, 14:47732 (J;US)
Karasev, V.E., X-ray photoelectron spectra and luminescence of europium (3) anthranilates, 14:47509 (RA;SU;In Russian)
Kasai, Atsushi, *See* Moriuchi, Shigeru, 14:47961
Kaschnitz, E., *See* Jaeger, H., 14:47355
Kashiwagi, T., Effects of thermal stability and melt viscosity of thermoplastics on piloted ignition, 14:47654 (BA;US)
Kassman, J.S., *See* Robin, A.M., 14:46816
Kataev, A.L., *See* Gorishny, S.G., 14:48351
Kato, Akishi, E_7 type modular invariant Wess-Zumino theory and Gepner's string compactification, 14:48366 (RA;JP)
Introduction to conformal field theories, 14:48411 (RA;JP)
Kato, Takashi, *See* Yamamura, Hidemasa, 14:48687
Katoh, Toshio, Measurement of activation cross sections, 14:48433 (R;JP;In Japanese)
Kauffman, C.W., *See* Pu, Yi Kang, 14:47695
Kauffman, S.A., Selectable sets of novel proteins: catalytic and other properties. Final report, 1 July-30 September 1988, 14:48099 (R;US)
Kauffman, W.C., *See* Pu, Yi Kang, 14:47694
Kaufmann, M., Parallel version of the Boyer-Moore prover. Technical report, 14:48712 (R;US)
Kauppinen, E., Real time measurement of combustion aerosol size distributions, 14:47778 (R;FI;In Finnish)
Kavun, V.Ya., ^{1}H, ^{19}F, NMR study of crystal dynamics of ammonium and rubidium pentafluorouranylates, 14:47549 (RA;SU;In Russian)
Kawade, Kiyoshi, *See* Katoh, Toshio, 14:48433
Kawaguchi, Osamu, Combustion of coal char agglomerates in a combustion gas environment, 14:46851 (BA;US)
Kawahata, K., *See* Ida, K., 14:48648
Kawakami, T., Measurement of slow burning velocity by zero-gravity method, 14:47680 (BA;US)
Kawamura, T.A., Mixed waste characterization and certification at the Nevada Test Site, 14:46939 (RA;US)
Kawamura, Takeshi, *See* Asato, Katsuo, 14:47670
Kawano, Katsumi, *See* Yamamura, Hidemasa, 14:48687
Kawano, Masakatsu, *See* Ikeshima, Yoshiaki, 14:47118
Kay, S.R., *See* Griffiths, J.F., 14:47679
Kazdaev, Kh.R., Combined implantation of carbon and nitrogen ions in molybdenum, 14:47362 (RA;SU;In Russian)
Kazmerski, L.L., Investigation of impurity neutralization and defect passivation in polycrystalline silicon solar cells, 14:47454 (BA;US)
Keane, M.J., *See* Wallace, W.E., 14:47943
Keay, L., *See* Fassbender, L.L., 14:47294
Keck, G., Comparison of hot particles in the Chernobyl fallout and in the nuclear weapons tests fallout, 14:47960 (RA;AT;In German)
See Parisot, M., 14:48105

Keck, J.C., *See* Chun, Kwang Min, 14:47302
See Law, R., 14:47688
Keddy, E.S., *See* Trujillo, V.L., 14:47752
Keder, N.L., *See* Eddy, M.M., 14:47529
Kee, R.J., A computational model of the structure and extinction of strained, opposed flow, premixed methane-air flames, 14:47667 (BA;US)
See Lutz, A.E., 14:47686
Keepin, G.R., Nuclear fission and nuclear safeguards: Common technologies and challenges, 14:47008 (R;US)
Kefauver, H.L., Video imaging systems: A survey, 14:47848 (R;US)
Kei Ito., Milnor monodromy of singularities and chiral primary fields of N=2 superconformal field theories, 14:48394 (R;XA)
Tachyons in N=2 superconformal models and topological instability of defining the polynomial of Calabi-Yau manifolds, 14:48387 (R;XA)
Keiper, J.B., Generalized BDF [backward differentiation formula] methods applied to Hessenberg form DAEs, 14:48725 (R;US)
Keller, C., Stress measurements with the sea Calip gauge, 14:47882 (RA;US)
See Hudson, B., 14:47900
Keller, L.E., *See* Adams, R.C., 14:47950
Kelley, M.J., *See* Schauss, R.D., 14:47197
Kelly, J., *See* Schefer, R.W., 14:47614
Kelly, J.T., *See* Namazian, M., 14:47592
Kempa, J., Verification of high energy interaction model using data on cosmic rays in the atmosphere, 14:48177 (RA;PL)
Kenefick, R.A., *See* Shimizu, H., 14:48295
Kenk, G., Open-top chamber experiments for investigating the effect of pollutants on growth and health of forest (feasibility study), 14:48142 (R;DE;In German)
Kennedy, R.T., *See* Geng, L., 14:47535
Kennel, S., *See* Holmberg, E., 14:48101
Kennel, S.J., [Collaborative research on the tumor antigen TSP-180]: Foreign trip report, July 1–17, 1988, 14:48088 (R;US)
Kennerly, J.M., *See* Hutchison, C.A., 14:46935
Kenney, F.T., [Studies on the mechanism of insulin control of gene expression]: Foreign trip report, July 8–19, 1988, 14:48089 (R;US)
Kenoyer, J.L., *See* Lyon, M., 14:47837
See Moeller, M.P., 14:47155
Kephart, R., *See* Stefanski, R., 14:47784
Kerber, R.L., Statement on superconductivity, 14:47714 (R;US)
Kerfoot, H.B., *See* Diem, D.A., 14:47983
Kerley, G.I., Theory of calcite equation of state, 14:47445 (R;US)
Kernbichler, W., *See* Heindler, M., 14:48679
Kernoff, R.S., *See* Thompson, A.C., 14:47459
Kershaw, R., *See* Niu, C.M., 14:47387
Kestel, B.J., Polishing methods for metallic and ceramic transmission electron microscopy specimens: Revision 1, 14:47329 (R;US)
Kevorkian, J., Nonlinear resonance: Annual report, 14:47742 (R;US)
Khadkikar, S.B., Some theoretical aspects of cold fusion. A report, 14:48470 (R;XA)
Khan, A.A., *See* Wichner, R.P., 14:46976
Khan, F.S., *See* Allen, P.B., 14:48536
Khan, I., *See* Akhtar, T., 14:48128
Khan, I.A., On some integral relations involving a generalized hypergeometric polynomial, 14:48551 (R;XA)
Khan, L.A., *See* Akhtar, K.M., 14:47120
See Younus, M., 14:47117
Khan, M.M., *See* Tewarson, A., 14:47645
Khazan, S.M., *See* Volkov, E.D., 14:47368
Khizhnyak, N.A., *See* Mushnikov, V.N., 14:48513
Khodzhaev, O.F., *See* Shodiev, U.M., 14:47489
Khokhlov, A.V., *See* Dorokhova, N.I., 14:47488
Khomenko, V.S., Spectrochemical study of adducts of rare earth fluorinated β-diketonates, 14:47508 (RA;SU;In Russian)
Khvingiya, N.L., Heavy quarkonia in smoothed potential, 14:48346 (RA;SU;In Russian)
Kienzle-Focacci, M.N., *See* Bonvin, E., 14:48292
Kiernan, M.T., *See* Duke, J.C. Jr., 14:47440
Kilb, D.L., *See* Fogel, M.B., 14:47872
Kim, C.H., *See* Niu, C.M., 14:47387
Kim, M.H., *See* Geng, L., 14:47535
Kimberley, J.A., *See* Rao, A.K., 14:47313
Kimura, Kazuhiro, Interacting models on the torus, 14:48368 (RA;JP)
Kindel, J.M., *See* Mendel, C.W. Jr., 14:48691
King, C.G., *See* Kanithi, H.C., 14:47732
King, G.B., *See* Fiechtner, G.J., 14:47468
King, W.E., Rutherford-backscattering study of high-temperature oxidation of Y-implanted Fe-24Cr, 14:47384 (J;US)
Kingston, A.E., *See* Fon, W.C., 14:48258
Kini, A.M., *See* Williams, J.M., 14:47347
Kinnear, A.G., *See* Miller, B.G., 14:46887
Kinsman, J.D., Contribution of deforestation to atmospheric CO_2 and reforestation as an option to control CO_2, 14:47923 (R;US)
Kintsurashvili, M.Sh., *See* Diasamidze, Eh.M., 14:47367
Kirchgessner, D.A., *See* Slaughter, D.M., 14:46876
Kirichenko, V.G., *See* Igrushin, V.V., 14:47363
Kirilenko, V.V., ^{79,81}Br NQR study of phase transition in $CsHg_2Br_5$, 14:47512 (RA;SU;In Russian)
Kirillova, E.V., *See* D'yachkova, T.A., 14:47521
Kiritsis, E.B., Non-standard bosonization techniques in conformal field theory, 14:48423 (J;US)
Kirk, H.G., *See* Wang, X.J., 14:47799
Kirkham, R.R., *See* Phillips, S.J., 14:46946
Kirschner, R., Logarithmic asymptotics of amplitudes in QCD, 14:48331 (RA;PL)
Kirvel, R.D., *See* Struble, G.L., 14:47245
Kitazawa, Hideo, *See* Igashira, Masayuki, 14:48447
Kitazawa, Yoshihisa, *See* Kato, Akishi, 14:48366
Klauber, W., *See* Lupo, J.F., 14:47887
See Patch, D.F., 14:47886
See Rimer, N., 14:47888
Klein, M., Determination of the leptonic neutral current couplings, 14:48303 (RA;PL)
Kleinman, L., *See* Antoniewicz, P.R., 14:47344
Kleinstreuer, C., *See* Ramachandran, R.S., 14:47758
Klem, J.F., *See* Jones, E.D., 14:47447
Klemm, R.B., *See* Patterson, P.M., 14:47482
Klibanov, A., *See* Holmberg, E., 14:48101
Klimas, K.I., *See* Malachesky, P.A., 14:47205
Klotsman, S.M., *See* Arbuzov, V.L., 14:47361
Klyukovich, V.A., *See* Mushnikov, V.N., 14:48513
Kneisler, R.J., *See* Fiechtner, G.J., 14:47468
Knetl, G., *See* McGough, M.S., 14:47193
Kniehl, R., *See* Blaser, P., 14:47071
Knight, D.K., *See* Pink, P.N., 14:48742
Knill, K.J., *See* Smart, J.P., 14:46872
Knoesen, A., *See* Kowel, S.T., 14:47849
Knox, W.H., *See* Hull, A.P., 14:47154
Knuenz, D., *See* Amann, T., 14:47070
Knystautas, R., *See* Jarosinski, J., 14:47579
See Teodorczyk, A., 14:47689
Ko, G.H., Correlations for effects of coal type and pressure on tar yields from rapid devolatilization, 14:46853 (BA;US)
Kobayakawa, H., *See* Ando, M., 14:47817
Kobayashi, K., *See* Shimizu, H., 14:48295
Kobayashi, Tatsuo, Classifications of Z_N orbifold models, 14:48379 (RA;JP)
Kobayashi, Y., *See* Shimizu, H., 14:48295
Kobets, L.V., Spectroscopic study of U(5) coordination compounds, 14:47551 (RA;SU;In Russian)
Koch, L., Burnup determination by the isotope correlation technique. Summary, 14:47094 (RA;XA)
Koch, M., *See* Bley, U., 14:47537
Kocher, D.C., Relationship between kidney burden and radiation dose from chronic ingestion of U: Implications for radiation standards for the public, 14:48139 (J;US)
See Lee, D.W., 14:46958
Koda, S., *See* Nomaguchi, T., 14:46916
Koeberl, C., Kara and Ust-Kara impact structures (USSR) and their relevance to the K/T boundary event, 14:48199 (RA;US)
Koehler, D.R., *See* Watkins, R.D., 14:47446
Koga, R., *See* Axness, C.L., 14:47821
Kohout, L.L., Cryogenic reactant storage for lunar base regenerative fuel cells, 14:47203 (R;US)

Kohse-Hoeinghaus, K., The quantitative LIF (laser-induced fluorescence) determination of OH concentrations in low-pressure flames, 14:47465 (BA;US)
See Meier, U., 14:47467
Kolde, S., *See* Nagata, A., 14:48651
Kojima, M., *See* Taniguchi, Y., 14:48685
Kolasinski, W.A., *See* Axness, C.L., 14:47821
Kolb, C.E., *See* Yetter, R.A., 14:47622
Kolb, T., Reduction of NO_x emission in turbulent combustion by fuel-staging/effects of mixing and stoichiometry in the reduction zone, 14:46915 (BA;US)
Kolesnichenko, V.L., *See* Volkov, S.V., 14:47510
Kolesnikov, E.M., Isotopic investigations in the area of the Tunguska catastrophe in 1908 year, 14:48200 (RA;US)
Kolnberger, S., Influence of fluctuations on the phase transformations in the superconductor, 14:47358 (RA;AT;In German)
Komarov, I.V., Lanthanide shift reagent complexing with quaternary ammonium salts in low-polarity solvents in the presence of water, 14:47522 (RA;SU;In Russian)
Komin, S.F., *See* Polyakov, A.A., 14:47093
Komissarov, V.N., *See* Dorokhova, N.I., 14:47488
Koncinski, W. Jr., Technology applications bulletins: Number one, 14:47243 (R;US)
Konno, Hitoshi, Covariant operator formalism of bosonic string theory, 14:48369 (RA;JP)
Kono, M., Mechanism of flame kernel formation produced by short duration sparks, 14:47303 (BA;US)
Konobeev, Yu.V., *See* Golubov, S.I., 14:47360
Konovalova, A.A., *See* Minin, V.V., 14:47490
Koontz, M.D., Topical report on a field-monitoring study of homes with unvented gas space heaters. Volume 4. Quality assurance/control procedures and results. Final report, January 1985-June 1987, 14:47952 (R;US)
Kopanets, I.E., *See* Tolstolutskaya, G.D., 14:47369
Kopyrin, A.A., *See* Afonin, M.A., 14:47517
Kordonskij, L.Eh., *See* Kalinichenko, N.B., 14:47495
Korepin, V.E., *See* Its, A.R., 14:48554, 14:48559
Kornilov, M.Yu., *See* Komarov, I.V., 14:47522
Korolev, V.V., *See* Afonin, M.A., 14:47517
Koryakova, O.V., *See* Zolotukhina, L.V., 14:47491
Kosower, D.A., *See* Bern, Z., 14:48424
Kossik, C.D., *See* Zimmerman, M.G., 14:46990
Kostka, A.G., *See* Appelman, E.H., 14:47556
Kotel'nilov, S.S., On a possibility of high-power pulsed source for e^-e^+ production on the base of laser fusion device, 14:47810 (RA;SU;In Russian)
Koulikov, N.V., Seasonal dynamics of ^{60}Co uptake by freshwater algae under natural conditions, 14:48047 (R;FR;In French)
Kounalakis, M.E., Turbulence/radiation interactions in nonpremixed hydrogen/air flames, 14:47649 (BA;US)
Kovacs, B., *See* Comings, D.E., 14:48086
Kovalev, Yu.G., *See* Maksimov, N.G., 14:48507
Kovaleva, I.S., *See* Boguslavskij, A.A., 14:47513
Kovchur, S.G., Investigation of erbium containing glass structure by EPR method, 14:48510 (RA;SU;In Russian)
Kowel, S.T., Microwave signal detection using modulation of polymeric optical waveguides: Final report, March–September 1988, 14:47849 (R;US)
Krajskaya, K.V., *See* Golovashkin, A.I., 14:47394
Krakowski, R.A., *See* Devoto, R.S., 14:48693
Kramer, G.S., *See* Pugh, C.E., 14:47107
Kramer, J.F., *See* Storm, C.B., 14:47859
Kramer, M., *See* Gokalp, I., 14:47710
Kramlich, J.C., *See* Chen, S.L., 14:46874
Krasnodubskaya, S.V., Electron spectroscopy of the gas phase of uranium (6) alkoxides, 14:47552 (RA;SU;In Russian)
Krasnoselov, V.A., *See* Pecherin, A.M., 14:47364
Krause, M.O., [Auger effect symposium]: Foreign trip report, March 30, 1989–April 11, 1989, 14:48277 (R;US)
Kraut, E., Structural aspects of band offsets at heterojunction interfaces, 14:47340 (RA;US)
Krautz, E., *See* Gruber, H., 14:47426
Kravers, M.A., *See* Andreeva, S.G., 14:47550
Kreisler, M., *See* Stefanski, R., 14:47784
Kreith, F., *See* Boehm, R.F., 14:47757
Kress, T.S., [Nuclear reactor severe accident chemistry]: Foreign trip report, June 1–9, 1988, 14:47115 (R;US)
[Status of the PHEBUS-FR severe accident research project]: Foreign trip report, November 13–18, 1988, 14:47150 (R;US)
Krier, D., Pre- and post-event elevation and horizontal surveys across the Yucca and Topgallant faults, Nevada Test Site, 14:47893 (RA;US)
Krishna, C.R., *See* Francis, A.J., 14:46839
Krishnan, A., *See* Ghoniem, A.F., 14:47595
Krishnan, R.P., [Coal conversion, renewable energy and energy efficiency in India]: Foreign trip report, October 31, 1988–December 8, 1988, 14:46882 (R;US)
[Fluidized bed combustion of high-ash Indian coals]: Foreign trip report, January 5, 1988–March 16, 1988, 14:46881 (R;US)
Krispel, F., *See* Hohenau, W., 14:47826
Kroeger, H., *See* Witze, P.O., 14:47701
Kroehl, H.W., *See* Ahn, B., 14:48234
Kroeninger, H., Reluctance motors in efficient variable-speed drive systems. Special report, 14:47315 (R;ZA)
Krome, E.C., *See* Lynch, M.P., 14:48050
Kroo, E., *See* Solomon, P.R., 14:46820
Kropp, W., *See* Baumann, N., 14:48304
Kross, B., *See* Bross, A., 14:47807
Krotscheck, E., Present status of the many-body problem, 14:48539 (RA;US)
Kruger, C.H., *See* Haussmann, G.J., 14:46864
Krumpelt, M., *See* Kumar, R., 14:47261
Krupa, D., Higher vector mesons in nucleon form factors, 14:48342 (RA;PL)
Kruse, M., *See* Dracoulis, G.D., 14:48456
Krushinina, M.V., *See* Zolotukhina, L.V., 14:47491
Krys, E., *See* Wasilewski, A., 14:48489
Krzesniak, J.W., Thyroid dose from ^{131} iodine of the population in Poland following the Chernobyl accident, 14:47129 (R;FR;In French)
Ksenofontova, N.M., Correlation studyj of the structure and spectroscopic characteristics of coordination compounds of double tungstates of alkali and rare earth elements, 14:47520 (RA;SU;In Russian)
See Kobets, L.V., 14:47551
Kuchnir, M., Thermal conduction of SSC [Superconducting Super Collider] wire, 14:47352 (R;US)
Kuegerl, G., Solution of the non-linear Boltzmann equation for a homogeneous hard-sphere gas, 14:48263 (RA;AT;In German)
Kuenen, J.G., *See* Bos, P., 14:46811
Kukacka, L.E., *See* Sugama, T., 14:47414
Kumamaru, Hiroshige, ROSA-IV/LSTF 5% cold leg break LOCA experiment run SB-CL-18 data report, 14:47095 (R;JP)
Kumar, K.S., *See* Weiss, J.F., 14:48118
Kumar, R., Fuel cells for vehicle propulsion applications: A thermodynamic systems analysis, 14:47261 (R;US)
Kundrat, V., *See* Krupa, D., 14:48342
Kuntz, S., Investigation on analysing computer-aided forest disease classifications, 14:48141 (R;DE;In German)
Kunze, J.F., *See* Wang, J.L., 14:47199
Kunzmann, K., *See* Blaser, P., 14:47071
Kup, V.S., Spectral characteristics and structure of coordination ethylxanthates of lanthanides, 14:47518 (RA;SU;In Russian)
Kupchishin, A.I., *See* Zajkin, Yu.A., 14:47366
Kurbatova, L.D., Rapid technique of vanadium (4), determination in the presence of vanadium (5), 14:47476 (RA;SU;In Russian)
Kurimoto, H., *See* Yoshio, M., 14:47206
Kurita, Gen-ichi, *See* Yamaguchi, Yuji, 14:48652
Kusano, K., *See* Imada, K., 14:48093
Kushnirenko, I.Ya., *See* Andreeva, S.G., 14:47550
Kusse, B.R., *See* Hammer, D.A., 14:48671
Kusubov, A.S., Post-failure strength of gypsum silica-sand aggregate stemming material, 14:47885 (RA;US)
See Anderson, G.D., 14:47896
Kutter, B.L., *See* Davis, B.C., 14:47911
Kuzmany, H., *See* Jodlbauer, H., 14:47390
Kuznetsov, N.T., *See* Krasnodubskaya, S.V., 14:47552
Kuznetsov, S.I., *See* Volkov, S.V., 14:47510

Kuznetsova, I.Ya., *See* Boguslavskij, A.A., 14:47513
Kvale, T.J., Measurement of angular differential cross sections at the SSL Atomic Scattering Facility, 14:48274 (RA;US)
Kwasnik, A.F., *See* Durant, J.F., 14:46880
Kwech, H., *See* McGough, M.S., 14:47731
Kyrala, G.A., Air breakdown photography in the picosecond domain, 14:47719 (R;US)
The Los Alamos bright sources: Review of the physics and the diagnostic technology, 14:48273 (R;US)

L

La Nauze, R.D., *See* Agarwal, P.K., 14:46870
Labov, S., *See* Silver, E., 14:47850
Lackey, W.J., Ultrafine microstructure composites prepared by chemical vapor deposition. Annual report, January-December 1988, 14:47408 (R;US)
Lacomb, J.W., *See* Lupo, J.F., 14:47887
LaCroix, J.M., *See* Weitkamp, W.G., 14:47806
Ladd, A.J.C., *See* Hoover, W.G., 14:48280
Laderach, G.E., *See* Schneider, L.X., 14:48690
Laegreid, T., *See* Fossheim, K., 14:47402
Lake, G., STOA experiment in the European Parliament. The fusion project, 14:48699 (J;GB)
Lakshmisha, K.N., Behavior of methane-oxygen-nitrogen mixtures near flammability limits, 14:47676 (BA;US)
Lam, F.W., The behavior of polycyclic aromatic hydrocarbons during the early stages of soot formation, 14:47563 (BA;US)
Lam, S.H., Understanding complex chemical kinetics with computational singular perturbation, 14:47623 (BA;US)
Lamb, D.W., Streamer to glow transition in the positive air corona, 14:48238 (RA;AU)
Lamb, T., *See* Gouldin, F.C., 14:47583
Lampe, J.A., *See* Carlson, R.L., 14:47226
Lan, J.S., *See* Albrecht, R.W., 14:47124
Landis, D., *See* Silver, E., 14:47850
Lang, H., Heat energy saving by walls with transparent thermal insulation layers - measured results in idealised boundary conditions. Interim report, 14:47269 (R;DE;In German)
Lang, W., Hall effect in ceramic high-temperature superconductors, 14:47391 (RA;AT;In German)
See Jodlbauer, H., 14:47390
See Markowitsch, W., 14:47424
Langenbach, J.W., Three mile island unit 2 postaccident reactor building entry program, 14:47170 (J;US)
Langlois, R.G., *See* Jensen, R.H., 14:48094
Langner, G.H. Jr., *See* Martz, D.E., 14:48140
Langstaff, J.E., *See* Modica, L.G., 14:47969
Lanier, R.G., *See* Namboodiri, M.N., 14:48460
Lapicki, G., *See* McDaniel, F.D., 14:48281
Lapins, A., Preliminary assessment/site investigation: Tooele Army Depot, Utah. Volume 2. South Area. Final report, 14:48017 (R;US)
Laramore, G.E., Extended fine structure in appearance potential spectroscopy as a probe of solid surfaces, 14:47339 (RA;US)
Larin, G.M., *See* Minin, V.V., 14:47490
See Shodiev, U.M., 14:47489
Larin, S.A., *See* Gorishny, S.G., 14:48351
Larin, V.N., *See* Borisov, G.V., 14:48349
Larsen, J.W., *See* Maioriello, J., 14:46819
Larson, D.B., *See* Stout, R.B., 14:47880
Larson, P.B., Progressive mineral alteration and coupled ^{18}O depletions in the Lake City hydrothermal system (23 Ma), Colorado, 14:47061 (RA;US)
Laschka, D., Radiological effects of Chernobyl reactor accident on the lakes of Southern Bavaria, 14:47125 (R;FR;In French)
Lasheras, J.C., *See* Lazaro, B.J., 14:47708
Laskey, K.J., *See* Patnaik, G., 14:47671
Lastochkina, V.A., *See* Ksenofontova, N.M., 14:47520
Latorre, V.R., EMI [electromagnetic interference] potential of proposed 115KV line near B-691, 14:47842 (R;US)
Lau, A.K.C., *See* Abdel-Gayed, R.G., 14:47602
Laurendeau, N.M., *See* Fiechtner, G.J., 14:47468
See Waters, B.J., 14:47557
Laurito, A.W., Evaluation of air sprays and unique foam application methods for longwall dust control. Research report (Final), 14:46844 (R;US)
Lavelle, M.J., *See* Hawkins, W.L., 14:47891
Law, B.E., FY 1988 USGS [US Geological Survey] annual report, 14:46905 (R;US)
Law, C.K., Dynamics of stretched flames, 14:47659 (BA;US)
See Axelbaum, R.L., 14:47569
See Cho, P., 14:47603
See Du, D.X., 14:47570
See Sorbo, N.W., 14:47709
Law, R., Rate-controlled constrained equilibrium calculation of ignition delay times in hydrogen-oxygen mixtures, 14:47688 (BA;US)
Lazarev, L.N., *See* Afonin, M.A., 14:47517
Lazaro, B.J., Droplet dispersion and transport mechanisms in a turbulent, free shear-layer, 14:47708 (BA;US)
Lazo, E.N., The TMI-2 [Three Mile Island Unit 2] reactor building gross decontamination experiment: Effects on loose-surface contamination levels, 14:47173 (J;US)
Leach, D.D., *See* Weitkamp, W.G., 14:47806
Lebedev, V.N., *See* Bour-Moskalenko, Z.O., 14:47475
Lebo, I.G., *See* Kotel'nilov, S.S., 14:47810
Lechevin, J.M., *See* Mestries, J.C., 14:48138
Leclaire, R.J. Jr., Beam profile effects on NPB performance, 14:47795 (R;US)
Leden, L., Methods for municipal traffic safety work - improvement of traffic environment. A literature survey, 14:47280 (R;FI;In Finnish)
Lederer, N.D., *See* Walker, D.A., 14:47972
Lederman, L., Nuclear power plants: Using PSA to enhance operational safety, 14:47161 (J;XA)
Lee, C., *See* Walton, J., 14:47776
Lee, C.C., *See* Shapiro, W., 14:47720
Lee, D.J., *See* Cable, A.S., 14:46964
See Jahn, R.K., 14:47307
Lee, D.W., Performance assessment for future low-level waste disposal facilities at ORNL, 14:46958 (R;US)
Lee, E.H., *See* Hartman, F.C., 14:48096
Lee, E.L., *See* Aldis, D.F., 14:47865
Lee, I.Y., *See* Young, G.R., 14:48444
Lee, J.D., *See* Devoto, R.S., 14:48693
Lee, J.H.S., *See* Jarosinski, J., 14:47579
See Teodorczyk, A., 14:47689
Lee, L.M., *See* Reed, R.P., 14:47444
Lee, P.H.Y., *See* Kyrala, G.A., 14:47719, 14:48273
Lee, R.T., *See* Pattipati, K.R., 14:48719
Lee, S., *See* Wright, L.L., 14:47030
Lee, S.A., *See* Kyrala, G.A., 14:48273
Lee, S.Y., Mineralogical characterization of selected shales in support of nuclear waste repository studies: Progress report, October 1987–September 1988, 14:46974 (R;US)
See Wei, J., 14:47792
Lee, T.Y., Neutron streaming benchmark calculations, 14:47116 (R;US)
Lee, W.R., RBE [relative biological effectiveness] of tritium beta radiation to gamma radiation and x-rays analyzed by both molecular and genetic methods, 14:48121 (R;US)
Lee, Y.Y., Heavy ion acceleration at the AGS: Present and future plans, 14:47790 (R;US)
Leeb, H., *See* Oberhummer, H., 14:48676
See Schnizer, W.A., 14:48568
Leenders, L., *See* Blanpain, P., 14:47089
Lees, P., *See* Matanoski, G., 14:47956
Legrand, A.P., Solid phase coal liquefaction by mild hydrogenation. Solid NMR studies, 14:46837 (R;FR;In French)
Legrand, S., *See* Maye, J.P., 14:47050
Lehner, F., *See* Wiesinger, G., 14:47356
Lehto, W.K., *See* Gale, J.G., 14:47133
Leino, R.L., Effects of acid and aluminum on swim bladder development and yolk absorption in the fathead minnow, pimephales promelas, (journal version), 14:48146 (R;US)
Leisch, M., *See* Eisl, M., 14:47422
Leising, G., *See* Abt, R., 14:47423
See Eisl, M., 14:47422

Leitch, M.J., Low-energy pion double charge exchange and nucleon-nucleon correlations in nuclei, 14:48475 (R;US)
Leitner, H., Digital two-dimensional scintillation dosimetry, 14:48110 (RA;AT;In German)
See Poier, E., 14:48125
See Stuecklschweiger, G., 14:47809
Leitner, O., *See* Abt, R., 14:47423
Lengsfield, B.H. III, *See* Schneider, B.I., 14:48272
Lenze, B., *See* Liu, Y., 14:47604
Leonard, G., Coal-fueled diesel: Technology development: Final report, 14:47305 (R;US)
Leonard, G.L., *See* Hsu, B.D., 14:47314
Leonowich, J.A., *See* Lyon, M., 14:47837
Lepikko, J., Report on on-line pulverized coal flow meters, 14:47079 (R;FI;In Finnish)
Leppard, W.R, *See* Pitz, W.J., 14:47021
Leray, T., *See* Finkbeiner, F., 14:47281
Lestrade, J.P., Angular response calibration of the burst and transient source experiment, 14:47830 (RA;US)
Leuckel, W., *See* Gokalp, I., 14:47710
See Kolb, T., 14:46915
Leupold, H.A., Method of mass-producing superconducting persistent current rings, 14:47736 (P;US)
Method of transforming a passive ferromagnetic material into a permanent magnet, 14:47735 (P;US)
Superconducting shielded PYX PPM stacks, 14:47733 (P;US)
Superconducting shielded PYX PPM (periodic permanent magnet) stacks, 14:47734 (P;US)
Levan, D.A., *See* Embury, M.C., 14:48701
Levchuk, L.G., *See* Mushnikov, V.N., 14:48513
Levin, J.C., Synchrotron-radiation experiments with recoil ions, 14:48244 (R;US)
Levin, M., Geohydrological appraisal of the Vaalputs radioactive waste disposal facility in Namaqualand, South Africa, 14:46977 (R;ZA)
Levine, M., *See* Matanoski, G., 14:47956
Levine, S.M., Surface structure of silica glasses by molecular dynamics simulations, 14:47453 (BA;US)
Levy, A.V., Erosion-corrosion of materials by coal-water slurries, 14:46827 (BA;US)
Levy, R.P., Stereotactic heavy-charged-particle Bragg peak radiosurgery for the treatment of intracranial arteriovenous malformations in childhood and adolescence, 14:48112 (J;US)
Levy, S.S., *See* Bolivar, S.L., 14:46970
Lewellen, W.S., Feasibility report for a dispersion predictability model, 14:47957 (R;US)
Lewis, G.S., An investigation of the structure of a laminar nonpremixed flame in an unsteady vortical flow, 14:47580 (BA;US)
Lexa, G.F., *See* Durant, J.F., 14:46880
Leyer, J.C., *See* Gabano, J.D., 14:47301
Li, J., *See* Wu, C.K., 14:46861
Li, S.C., An investigation of combustion of boron suspensions, 14:47706 (BA;US)
Liao Zumin, Heavy isotope method for burnup determination of HFETR fuel elements, 14:47123 (RA;XA)
Libby, P.A., *See* Bray, K.N.C., 14:47606
Lichtner, P.C., Multiple reaction path model describing mass transfer in geochemical systems, 14:48165 (RA;US)
Lie, K., *See* Peterson, E.W., 14:47906
See Rimer, N., 14:47871, 14:47874
Lie, K.H., *See* Nilson, R.H., 14:47905
Lieske, C.N., *See* Meyer, H.G., 14:48085
Lignola, P.G., JSFR (Jet Stirred Flow Reactor) combustion processes of n-heptane and isooctane, 14:47682 (BA;US)
Likos, W.E., *See* Ryan, T.W. III, 14:46826
Liljenberg, G.W., Assessment of the effect on the gas industry of the National Appliance Energy Conservation Act of 1987. Topical report, November 1988, 14:46908 (R;US)
Lilly, W.D., *See* Perkins, M.T., 14:46822
Lim, C.S., Possible discontinuity in octupole behaviour in the Pt-Hg region, 14:48455 (R;AU)
See Vermeer, W.J., 14:48450
Lin-Liu, Y.R., *See* Mazdiyasni, K.S., 14:47713
Lince, J.R., Chemical effects of Ne(+) bombardment on the $MoS_2(0001)$ surface studied by high-resolution photoelectron spectroscopy. Technical report, 14:48495 (R;US)
Lindberg, S.E., 1988 annual report of the Integrated Forest Study, 14:47933 (R;US)
Lindemuth, I.R., Exploding metallic foil fuse modeling at Los Alamos, 14:47766 (R;US)
Solid fiber Z-pinches: "Cold-start" computations, 14:48656 (R;US)
Lindman, E.L., *See* Mendel, C.W. Jr., 14:48691
Linehan, J.C., *See* Pyne, J.W., 14:46804
Linev, V.N., Small-size spectrometers automated on the base of microprocessors and microcomputers, 14:47844 (RA;SU;In Russian)
Lipkin, H.J., Symmetry, topology and helicity in $D_s \rightarrow \omega\pi$ and $D_s \rightarrow \rho\pi$ decays, 14:48323 (R;US)
List, R.S., *See* Arko, A.J., 14:48531
Lisyanskii, V.V., *See* Borisov, A.A., 14:47620
Litka, T.J., *See* McGough, M.S., 14:47731
Litt, R.D., Nested-fiber filter for high-temperature and high-pressure particulate removal: Final report, 14:46840 (R;US)
Littler, C.L., Two-photon absorption characterization. Interim performance report, 28 August-27 November 1988, 14:47409 (R;US)
Littler, J., *See* Robinson, P., 14:47266
Liu, C.T., [Alloy phase stability and intermetallic research]: Foreign trip report, June 12–July 11, 1987, 14:47371 (R;US)
Liu, H., Extruded coal capsules for transport in fiber-water flow: Final technical report, 14:46845 (R;US)
Liu, J.Z., *See* Arko, A.J., 14:48531
See Rehn, L.E., 14:48497
Liu, K.C., [Mechanical testing of advanced ceramics]: Foreign trip report, April 11–15, 1988, 14:47761 (R;US)
Liu, P., *See* Tsang, I., 14:46944
Liu, R., *See* Arko, A.J., 14:48531
Liu, S.H., [The theory of ac impedance of rough electrode-electrolyte interfaces]: Foreign trip report, May 19, 1989–June 5, 1989, 14:47534 (R;US)
Liu, Y., The influence of turbulence on the burning velocity of premixed CH_4-H_2 flames with different laminar burning velocities, 14:47604 (BA;US)
Livingston, B.L., Improving state outreach to small communities. Technical report, 14:48060 (R;US)
Ljadov, G.D., Techniques and equipment for determination of fuel burnup in water cooled reactors, 14:47090 (RA;XA)
Ljungdahl, L.G., *See* Pham, V.T., 14:47530
Llave, F.M., Laboratory study of nitrogen miscible displacement of light oil, 14:46892 (R;US)
Lloyd-Evans, J., *See* Haines, T.J., 14:48183
Lo, C.K., *See* Banks, H.T., 14:48574
Locklin, D.W., *See* Murphy, M.J., 14:46917
Lockwood, F.C., Fire computation: The flashover phenomenon, 14:47653 (BA;US)
The prediction of swirl burner pulverized coal flames, 14:46858 (BA;US)
Lodde, G.M., Control of the TMI-2 [Three Mile Island Unit 2] reactor building environment, 14:47183 (J;US)
The significance of radiological control documentation in litigation, 14:47177 (J;US)
Loeffler, S., *See* Gerhardt, P., 14:47571
Loesser, G. D., Design of the TFTR [Tokamak Fusion Test Reactor] maintenance manipulator, 14:48703 (J;US)
Logan, B.G., *See* Devoto, R.S., 14:48693
Logfullin, R.Sh., *See* Boguslavskij, A.A., 14:47501
Lohner, R., *See* Ambrosiano, J., 14:48662
Long, M.B., Measurement of three-dimensional concentrations in turbulent jets and flames, 14:47599 (BA;US)
Longacre, R.S., *See* Love, W.A., 14:47839
Longley, H., *See* Otlet, R., 14:47959
Longstaff, T.A., Scientific data manipulation using attribute constaints, 14:48737 (R;US)
Longwell, J.P., *See* Lam, F.W., 14:47563
See Wornat, M.J., 14:46855
Loo, B., Space of harmonic maps of S^2 into S^4, 14:48561 (R;XA)
Lorah, M.M., *See* Herman, J.S., 14:47064

Lorentzen, G., Refrigeration for food and people: an essential technology for the welfare of man, 14:47233 (R;US)
Lorenz, J.C., Fracture characteristics and reservoir behavior of stress-sensitive fracture systems in flat-lying lenticular formations, 14:46896 (J;US)
Lotfullin, R.Sh., *See* Boguslavskij, A.A., 14:47513
See Boguslavskij, L.A., 14:47502
See Kirilenko, V.V., 14:47512
Lotze, K.H., Production of photons in anisotropic spacetimes, 14:48391 (R;XA)
Loughran, E.D., *See* Morris, C.E., 14:47433
Louie, S.G., Ab initio calculations of materials properties, 14:47335 (RA;US)
Love, W.A., Some TPC measurements in an oxygen beam at the AGS, 14:47839 (J;NL)
Lovell, A.B., Benzene oxidation perturbed by NO_2 addition, 14:47634 (BA;US)
Lowe, D.R., Evidence for and implications of an Early Archean terrestrial impact record, 14:48201 (RA;US)
Lowson, R.T., *See* Jeffery, J.J., 14:46984
Lozinskij, M.O., *See* Khomenko, V.S., 14:47508
Lu, X, *See* Haines, T.J., 14:48183
Lubatti, H., *See* Stefanski, R., 14:47784
Lubuma, M.S., Generalization of the spaces l_p, 14:48545 (R;XA;In French)
Lucas, D., Pulsed plasma jet igniters: Species measurements in methane combustion, 14:47684 (BA;US)
Luchente, M., Spatial and frequency dependence of four-wave mixing in broad-area diode lasers, 14:47737 (R;US)
Lucke, R.B., *See* Pyne, J.W., 14:46804
Luckhaus, S., *See* Duong Minh Duc, 14:48541
Ludlam, T.W., *See* Samios, N.P., 14:47789
Lueers, B., *See* Boehm, H., 14:47572
Luensmann, W., *See* Laschka, D., 14:47125
Luh, P.B., *See* Pattipati, K.R., 14:48719
Luk'yanets, E.A., *See* Tomilova, L.G., 14:47504
Lukey, B.J., *See* Meyer, H.G., 14:48085
Lunin, G.L., *See* Polyakov, A.A., 14:47093
Luoma, M., Outdoor air intake in dwellings equipped with mechanical exhaust ventilation, 14:47277 (R;FI;In Finnish)
Lupo, J., *See* Patch, D.F., 14:47886
Lupo, J.F., Predicting the response of shock-conditioned tuff from Rainier Mesa using laboratory tests, 14:47887 (RA;US)
Lupu, A.T., *See* Grishechkina, S.P., 14:48514
Lusk, M., *See* Hoffman, R.L., 14:47989
Luther-Davies, B., Past two years of laser fusion, 14:48683 (RA;AU)
See Maddever, R.A.M., 14:48608
Lutsko, T.P., *See* Antonov, P.G., 14:47514
Lutz, A.E., Dynamic effects of autoignition centers for hydrogen and $C_{1,2}$-hydrocarbon fuels, 14:47686 (BA;US)
Lutz, T.M., Magnetic reversal spurts: Rain gauges for comet showers, 14:48202 (RA;US)
Luxmoore, R.J., [Responses of coniferous species to atmospheric CO_2 enrichment]: Foreign trip report, September 19–30, 1988, 14:47928 (R;US)
Luyben, K.C.A.M., *See* Bos, P., 14:46811
Lyman, J.T., *See* Levy, R.P., 14:48112
Lynch, C.S., *See* Hearst, J.R., 14:47897
Lynch, J.G., *See* Bonvin, E., 14:48292
Lynch, M.P., Understanding the estuary: Advances in Chesapeake Bay research, 14:48050 (R;US)
Lynn, B.W., *See* Frieman, J.A., 14:48417
Lynn, J.E., Resonance effects in neutron scattering lengths, 14:48487 (R;US)
Lyo, S.K., *See* Jones, E.D., 14:47447
Lyon, C.E., *See* Rankin, W.N., 14:46955
Lyon, M., Hanford radiological protection support services annual report for 1988, 14:47837 (R;US)
Lyons, C.P., *See* Reynolds, M.D., 14:47981
Lytle, F.E., *See* Fiechtner, G.J., 14:47468

M

Maas, U., Ignition processes in carbon-monoxide-hydrogen-oxygen mixtures, 14:47687 (BA;US)
MacAdam, S., *See* Levy, A.V., 14:46827
Maciocco, G., *See* Maestri, F., 14:47110
Mackay, D.J., Flame-jet ignition of large fuel-air clouds, 14:47655 (BA;US)
MacKenzie, E., Ionospheric scintillations/TEC and in-situ density measurements at an auroral location in the European sector. Environmental research papers, 2 October 1986-31 July 1987, 14:48232 (R;US)
Mackowski, D.W., Radiative properties of chain-agglomerated soot formed in hydrocarbon diffusion flames, 14:47647 (BA;US)
MacLellan, J.A., *See* Traub, R.J., 14:47148
Madden, N., *See* Silver, E., 14:47850
Maddever, R.A.M., Phase-modulation and the fundamental and second harmonic emission spectra from laser-produced plasmas, 14:48608 (RA;AU)
Madigozhin, D.T., *See* Dremin, I.M., 14:48239
Maeder, A., Grids of evolutionary models from 0.85 to 120 solar masses: Observational tests and the mass limits, 14:48224 (R;CH)
Tables of evolutionary star models from 0.85 to 120 solar masses with overshooting and mass loss, 14:48225 (R;CH)
Maerker, R.E., Analysis of the VENUS-3 experiments, 14:47105 (R;US)
Maesiar, P., *See* Krupa, D., 14:48342
Maestri, F., Design criteria and realization of a computerized supervisory system for nuclear applications, 14:47110 (R;IT)
Magette, T., Bibliography of the Maryland Power Plant and Environmental Review Division, tenth edition, 14:47256 (R;US)
Magnoli, D.E., A model to calculate effectiveness of a submarine-launched nuclear ASW weapon, 14:48708 (R;US)
Instructions for using SOW Pk program, 14:48754 (R;US)
Maguire, M.C., Weldability of ductile nickel aluminides, 14:47374 (R;US)
Mahaffey, K.R., Evaluation of research on cadmium inhalation-exposure estimate and their significance for kidney and liver cadmium burden, 14:48149 (R;US)
Mahajan, S.M., *See* Gratton, J., 14:48499
Mahmud, K., An HTP kinetics study of the reaction of $O(^3P)$ atoms with propylene over the 300 to 1215 K temperature range, 14:47536 (BA;US)
Mahmud, T., *See* Lockwood, F.C., 14:46858
Main, W., *See* Garate, E.P., 14:48665
Mains, R.K., Wigner-function modeling of resonant tunneling diodes with high peak-to-valley ratios, 14:47762 (R;US)
Maioriello, J., Low severity coal conversion by ionic hydrogenation: Progress report, May–July 1989, 14:46819 (R;US)
Majanen, A., *See* Roennberg, R., 14:47275
Majerotto, W., Restrictions on particle masses in supersymmetry, 14:48569 (RA;AT;In German)
Maksimov, M.N., *See* Antonov, P.G., 14:47514
Maksimov, N.G., EPR spectra peculiarities of $Y_1Ba_2Cu_3O_{7-x}$ system, 14:48507 (RA;SU;In Russian)
Peculiarities of electron distribution during sequential reduction of complex ruthenium sulfates, 14:47516 (RA;SU;In Russian)
Malachesky, P.A., Doped carbon electrodes for zinc-halogen batteries. Final report, February 1986-July 1986, 14:47205 (R;US)
Malalasekera, W.M.G., *See* Lockwood, F.C., 14:47653
Malinauskas, A.P., [Technical Program Committee for the European Nuclear Society/American Nuclear Society meetings]: Foreign trip report, March 26–April 2, 1988, 14:47149 (R;US)
Mallon, G.M., *See* Gesalman, C.M., 14:48073
Maloney, D.J., Evaporation, agglomeration, and explosive boiling characteristics of coal-water fuels under intense heating conditions, 14:46877 (BA;US)
See Phuoc, T.X., 14:46854
Malte, P.C., *See* Westbrook, C.K., 14:47616
Mandelkern, M., *See* Baumann, N., 14:48304
Mandler, J.W., INEL studies concerning solidification of low-level waste in cement, 14:46965 (R;US)
Mangiarotti, M., *See* Maestri, F., 14:47110

Manickam, J., *See* Miller, A., 14:48659
Manin, V.V., *See* Shodiev, U.M., 14:47489
Mankoc-Borstnik, N., Size of systems in massless collective states, 14:48327 (R;XA)
Mann, D.E., *See* Dery, V.A., 14:46948
Mann, R.C., *See* Jones, J.P., 14:47770
Mannsbart, W., *See* Brand, M., 14:47255
Manrod, W.E. III, *See* Yager, R.E., 14:46951
Mansour, M.S., Raman/Rayleigh and Mie-scattering measurements in a reverse flow reactor close to extinction, 14:47600 (BA;US)
Mansure, A.J., Steam-zone electrical characteristics for geodiagnostic evaluation of steamflood performance, 14:46895 (BA;US)
Mantooth, D.S., *See* Waite, D.A., 14:46988
Mantsch, P., *See* Errede, D., 14:47825
Manuel, A., *See* Peter, M., 14:47827
Maple, M.B., *See* Torikachvili, M.S., 14:47330
Marans, R.W., *See* Collins, B.L., 14:47273
Margolis, S.B., *See* Armstrong, R.C., 14:47697
Marimon, J.B., *See* Bonville, P., 14:47332
Mark, H., Energy in physics, war and peace, 14:47016 (B;US)
Markham, J.R., *See* Solomon, P.R., 14:46863
Markovic, V., Radiation chemistry: Little known branch of science, 14:47544 (J;XA)
Markowitsch, W., Infrared reflection and magnetic susceptibility of $Ba_{1-x}K_xBiO_{3-\delta}$, 14:47424 (RA;AT;In German)
See Jodlbauer, H., 14:47390
Markstein, G.H., Correlations for smoke points and radiant emission of laminar hydrocarbon diffusion flames, 14:47567 (BA;US)
Markum, H., *See* Gasser, I., 14:48345
See Gerstenmayer, E., 14:48344
Marland, G., *See* Kinsman, J.D., 14:47923
Marmolino, C., Differences between line bisectors in quiet and active sun, 14:48174 (R;US)
Marov, I.N., *See* Borisova, L.V., 14:47511
See Kalinichenko, N.B., 14:47495
Marrero, T.R., *See* Liu, H., 14:46845
Marshall, M., *See* Peaple, L.H.J., 14:47820
Martin, G.F., *See* Moeller, M.P., 14:47155
Martin, J.B., Emergency preparedness lessons from Chernobyl, 14:47159 (BA;US)
Martin, M., *See* Bonvin, E., 14:48292
See Walton, J., 14:47776
Martin, M.J., [Mass-chain nuclear structure and nuclear decay, Ghent, Belgium, May 16–20, 1988]: Foreign trip report, 14:48435 (R;US)
Martin, N.L., Emissions data for stationary reciprocating natural gas engines and gas turbines in use by the gas-pipeline-transmission industry (for microcomputers). Data file, 14:46912 (R;US)
Martin, R., *See* Kamp, G., 14:47218
Martin, R.S., *See* Williamson, A.D., 14:47951
Martin, T.H., An empirical formula for gas switch breakdown delay, 14:47767 (R;US)
See Vandevender, J.P., 14:48692
Martinez, A.B., *See* Bourqeois, B.S., 14:48717
Martino, L.E., A tracking system for hazardous waste minimization, 14:47214 (RA;US)
Martz, D.E., The half-life of ^{218}Po, 14:48140 (J;US)
Martz, H.E., *See* Pontau, A.E., 14:47480
Maruyama, K., *See* Holmberg, E., 14:48101
Maruyama, Yu, Database for the degraded core coolability experiments, 14:48744 (R;JP;In Japanese)
Marvin, U.B., Impact, and its implications for geology, 14:48203 (RA;US)
Marzi, R., Kinetics and quantitative analysis of the isomerization and aromatization of fossil steroid hydrocarbons within experiments and in naturally matured sample sequences, 14:46889 (R;DE;In German)
Marzocchella, A., *See* Lignola, P.G., 14:47682
Mashkarov, Yu.G., *See* Igrushin, V.V., 14:47363
Maskarinec, M.P., Stability of volatile organics in environmental water samples: Storage and preservation: Final report, 14:48029 (R;US)
Mason, M., Fiscal year 1988 measurable environmental results initiatives: Underground storage-tank impacts on ground water. Technical report, 14:48035 (R;US)
Mason, R.J., ANTHEM simulation of plasma opening switches, 14:47201 (R;US)
See Jones, M.E., 14:48655
Masri, A.R., Spontaneous Raman Measurements in turbulent $CO/H_2/N_2$ flames near extinction, 14:47590 (BA;US)
Massimilla, L., *See* Chirone, R., 14:46869
See Salatino, P., 14:46847
Massoletti, D., *See* Namboodiri, M.N., 14:48460
Mataga, T.G., *See* Cattolica, R.J., 14:47640
Matalon, M., *See* Buckmaster, J., 14:47672
Matanoski, G., Walk-through survey report, Gulfstream American Corporation (formerly Grumman-American Aviation Corp.) Savannah, Georgia, 14:47956 (R;US)
Matese, J.J., *See* Whitmire, D.P., 14:48213
Mathias, C., *See* Richardson, F.D., 14:47944
Mathys, G., Upper main sequence of OB associations. 1: Spectral types and lines of C and N of southern single-lined O stars, 14:48226 (R;CH)
Mathys, L., *See* Bonvin, E., 14:48292
Matsumoto, Hiroshi, *See* Tamai, Hiroshi, 14:48653
Matsunaga, Takeshi, *See* Moriuchi, Shigeru, 14:47961
Matsuoka, Takeo, Realistic superstring models. An introduction, 14:48364 (RA;JP)
Matsushita, T., Workshop on cooling of x-ray monochromators on high power beamlines, 14:47812 (R;JP)
Matthies, H., Measurements on the AEOLUS 11 wind power plant and comparison with rated loads, 14:47069 (R;DE;In German)
Mattus, A.J., *See* Bouniol, P.E., 14:47223
Maung, T., *See* Alvar, K.R., 14:47730
Mavko, B.B., Three-dimensional hydraulic fracture model development for application to and understanding of coal-bed methane-stimulation treatments. Final report, July 1, 1984-December 16, 1988, 14:46913 (R;US)
Maxwell, H.W., Drumlins - Potential low-level radioactive waste sites, 14:46949 (RA;US)
Maye, J.P., Modelization and identification of a latent heat buffer storage for its real time control, 14:47050 (R;FR;In French)
Mayville, R.A., *See* Rao, A.K., 14:47313
Mazdiyasni, K.S., High-temperature ceramic superconductors. Report for 1 January-31 March 1989, 14:47713 (R;US)
Mazur, P., [Meeting of the Society for Cryobiology]: Foreign trip report, July 8–27, 1988, 14:48097 (R;US)
Mazurekiewicz, J., *See* Pu, Yi Kang, 14:47695
Mazurenko, E.A., *See* Zub, V.N., 14:47498
McCaffrey, B.J., Combustion efficiency, radiation, CO and soot yield from a variety of gaseous, liquid, and solid fueled buoyant diffusion flames, 14:46902 (BA;US)
McCain, J.D., *See* Williamson, A.D., 14:47951
McCarthy, A.L., High power ion cyclotron resonance in JET: the JET radio frequency division and the JET team, 14:48609 (RA;AU)
McCarthy, I.E., Continuum effects in electron-helium total cross sections, 14:48255 (R;AU)
Electron scattering from atoms, 14:48253 (R;AU)
Ionisation of atomic hydrogen at intermediate momentum transfer, 14:48256 (R;AU)
See Allen, L.J., 14:48250
See Mitroy, J., 14:48247, 14:48257
McCarthy, I.E. and other, *See* Frost, L., 14:48249
McCarthy, J.M., *See* Chen, S.L., 14:46874
McCollor, D.P., Promotion of char oxidation by inorganic constituents, 14:46849 (BA;US)
McConnel, B.C., *See* Blanke, J.A., 14:46956
McConnell, L., *See* Lapins, A., 14:48017
McCord, R.A., *See* Voorhees, L.D., 14:46999
McCormick, J.H., *See* Leino, R.L., 14:48146
McCormick, N.J., *See* Albrecht, R.W., 14:47124
McCurdy, C.W., *See* Schneider, B.I., 14:48272
McDaniel, D.H., *See* Mendel, C.W. Jr., 14:48691
McDaniel, F.D., Charge state dependence of K X-ray production in thin targets by multicharged silicon ions, 14:48281 (J;NL)
McDonald, K.T., *See* Wang, X.J., 14:47799

McDonell, V.G., Application of two-component phase Doppler interferometry to the measurement of particle size, mass flux, and velocities in two-phase flows, 14:47469 (BA;US)
McGhan, V.L., Hanford wells, 14:48046 (R;US)
McGill, R.N., The Department of Energy's Federal Methanol Fleet, 14:47028 (B;US)
[USDOE's federal methanol fleet report to the international symposium on alcohol fuels]: Foreign trip report, November 10, 1988–November 23, 1988, 14:47317 (R;US)
McGough, M.S., Performance of the automated cutting equipment system during the plasma cutting of the TMI-2 [Three Mile Island Unit 2] lower core support assembly, 14:47193 (J;US)
Robotic delivery system for plasma cutting of the TMI-2 [Three Mile Island Unit 2] lower core support assembly, 14:47731 (J;US)
McGovern, D.E., *See* Schoeneman, J.L., 14:47724
McGuire, S.C., Fluctuation analysis of relativistic nucleus-nucleus collisions in emulsion chambers, 14:47831 (RA;US)
McHargue, C.J., [Structure-property relationships in surface-modified ceramics]: Foreign trip report, April 11–24, 1988, 14:47399 (R;US)
McHone, J.F., Shatter cones: Diagnostic impact signatures, 14:48204 (RA;US)
McIlwain, M., Introduction to workshop, 14:46795 (RA;US)
McIntyre, G.T., *See* Welch, K.M., 14:47801, 14:47804
McKenna, T.J., *See* Sjoreen, A.L., 14:47156
McKenzie, D.R., *See* Swift, P., 14:48270
See Turner, G.M., 14:48502
McKibben, C.J., *See* Wang, J.L., 14:47199
McKinley, B.J., *See* Carter, M.R., 14:47838
McKinley, T.L., Comparison of computed and measured air motion in circular and square piston cups, 14:47311 (B;US)
McKinnis, W.B., *See* Anderson, G.D., 14:47896
Mcknight, R.L., Structural analysis applications, 14:47775 (RA;US)
McKone, T.E., A review of GEOTOX for the EPA multi-media assessment project, 14:47986 (R;US)
Conventional weapons demilitarization: A health and environmental effects data base assessment: Methods for estimating multi-pathway exposures to environmental contaminants, Final report, Phase 2, 14:48155 (R;US)
GEOTOX multimedia compartment model user's guide supplement, 14:48288 (R;US)
McLaughlin, S.B. Jr., [Effects of air pollution on forest productivity in Southern Sweden]: Foreign trip report, December 4–9, 1988, 14:47930 (R;US)
McMillan, M.H., *See* Rao, A.K., 14:47313
McMillian, M.H., Coal-fueled diesels, 14:47312 (BA;US)
McNair, G.W., *See* Mitchell, D.H., 14:46982
McQuillan, B.W., *See* Mazdiyasni, K.S., 14:47713
Mecholsky, J.J., *See* Butt, D.P., 14:47403
Medina, L., *See* Krier, D., 14:47893
Megaridis, C.M., Soot aerosol dynamics in a laminar ethylene diffusion flame, 14:47566 (BA;US)
Mehner, A.W., Reference elements for irradiation testing under THTR-follow-up plant conditions to determine safe fission product retention. Final report, 14:47097 (R;DE;In German)
Meier, M.S., *See* Alvar, K.R., 14:47730
Meier, U., Discussion of two-photon laser-excited fluorescence as a method for quantitative detection of oxygen atoms in flames, 14:47467 (BA;US)
Mejklyar, V.P., *See* Akhmin, S.M., 14:47486
Mel'nikiv, V.N., *See* Babaev, V.P., 14:48512
Meldau, R.F., *See* Mansure, A.J., 14:46895
Mele, M.J., *See* Alerhand, O.L., 14:48279
Melius, C.F., *See* Miller, J.A., 14:47631
Melkonian, L., *See* Silver, E., 14:47850
Melosh, H.J., *See* Vickery, A.M., 14:48211
Melrose, D.B., Effect of small-scale inhomogeneities on the properties of waves in plasmas, 14:48641 (RA;AU)
Mendel, C.W. Jr., Launched electrons in plasma opening switches, 14:48691 (R;US)
Menguc, M.P., *See* Mackowski, D.W., 14:47647
Meo, G., *See* Gadomski, A.M., 14:47111
Mercer, L.P., Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (South Atlantic): Black sea bass, 14:48014 (R;US)
Merchant, D., Worker exposures during the TMI-2 [Three Mile Island Unit 2] recovery, 14:47180 (J;US)
Mercogliano, R., *See* Lignola, P.G., 14:47682
Merrigan, M.A., *See* Trujillo, V.L., 14:47752
Messerle, H.K., Plasma driven MHD power plant, 14:47259 (RA;AU)
Messmer, R., Theoretical considerations regarding impurities in silicon and the chemisorption of simple molecules on nickel, 14:47343 (RA;US)
Mestries, J.C., Influence of the association pyridostigmine-gamma irradiation (15 Gy) on the physical performances of the macacus cynomolgus, 14:48138 (RA;FR;In French)
Meszaros, P.S., *See* Whealton, J.H., 14:48668
Metghalchi, M., *See* Law, R., 14:47688
Meurice, Y., The classical harmonic oscillator on Galois and P-adic fields, 14:48425 (J;US)
Meyer, B.R., *See* Simpson, B.R.S., 14:48492
Meyer, H.G., Radioimmunoassay for pyridostigmine, 14:48085 (R;US)
Meyer, T., *See* Brand, M., 14:47255
Meynet, G., *See* Maeder, A., 14:48224, 14:48225
Miake-Lye, R.C., Lifted turbulent jet flames: A stability criterion based on the jet large-scale structure, 14:47612 (BA;US)
Michalek, J.E., *See* Wolfe, W.H., 14:48113
Michelotti, L., Exploratory orbit analysis of Tevatron helical upgrade: One: A first look, 14:47793 (R;US)
Middleton, C., *See* Struble, G.L., 14:47245
Mighetto, P.I., *See* Rose, S., 14:48084
Mihalovich, G.S., Demonstration of new handling equipment configurations for the overpacking of thorium materials, 14:46957 (RA;US)
Mikhlin, E.B., *See* Slavetskaya, A.I., 14:47505
Mikkelsen, J.C., Oxygen, carbon, hydrogen and nitrogen in crystalline silicon, 14:47450 (B;US)
Miklos, J. A., Development of a dose algorithm for the modified panasonic UD-802 personal dosimeter used at three mile island, 14:47176 (J;US)
Miley, G.H., *See* Heindler, M., 14:48679
Millage, K.K., Fission-product-decay characteristics. Master's thesis, 14:48463 (R;US)
Miller, A., Comparison of ballooning mode stability properties of tokamaks with circular and elliptic cross sections with the same poloidal flux, 14:48659 (R;US)
Miller, B.G., Pneumoconiosis in coal miners and exposure to dust of variable quartz content. Final report, December 1985-May 1988, 14:46887 (R;GB)
Miller, C.L., *See* Spear, R.H., 14:48449
Miller, J.A., A theoretical analysis of the reaction between hydroxyl and acetylene, 14:47631 (BA;US)
See Kee, R.J., 14:47667
See Lutz, A.E., 14:47686
Miller, J.D., *See* Golden, D.W., 14:47136
Miller, J.E., *See* Heagle, A.S., 14:48153
Miller, J.R., *See* Devoto, R.S., 14:48693
See Summers, L.T., 14:47726, 14:48695
Miller, M.K., An atom probe study of phase decomposition in three iron meteorites, 14:48176 (R;US)
Miller, P.D., *See* McDaniel, F.D., 14:48281
Miller, T.M., *See* Finnegan, D.L., 14:48196
Millett, I., *See* Silver, E., 14:47850
Millunzi, A.C., *See* Silady, F.A., 14:47114
Milly, D., *See* Jaffe, P.R., 14:48030
Milton, J., *See* Longstaff, T.A., 14:48737
Minchinton, A., Valence electronic structure of CH_3F and CH_3Cl: electron momentum distributions and separation energies, 14:48248 (R;AU)
Miner, J.C., *See* Wolfe, W.H., 14:48113
Minin, V.V., $MoOCl_3$ interaction with amines in the presence of dithioligands, 14:47490 (RA;SU;In Russian)
Mino, Yoshitaka., *See* Maruyama, Yu, 14:48744
Minotti, F., *See* Gratton, J., 14:48499

Minyaev, A.I., Application of XPS, UV- and IR-spectroscopy to structure study of V(5) complexes in surface phase at $SiO_2/VO_{2.5}$ interface and catalysts on their basis, 14:47524 (RA;SU;In Russian)
Mirochkin, A.G., *See* Karasev, V.E., 14:47509
Miroshnichenko, I.V., ESR study of products of ruthenium sulfate interaction with 5-amino-1,2,4-dithiazole-3-thione in sulfuric acid solutions, 14:47492 (RA;SU;In Russian)
See Sidorov, A.A., 14:47499
Mishra, S.C., Integrable classical systems in higher dimensions, 14:48550 (R;XA)
Misra, A.K., *See* Chandra, D., 14:46810
Misra, B., *See* Kumar, R., 14:47261
Misra, M.K., *See* Essenhigh, R.H., 14:46885
Missaghi, M., *See* Dixon-Lewis, G., 14:47665
Mitchell, D.F., *See* King, W.E., 14:47384
Mitchell, D.H., Performance assessment on grouted double-shell tank waste at Hanford, 14:46982 (R;US)
Mitchell, R.E., On the products of the heterogeneous oxidation reaction at the surfaces of burning coal char particles, 14:46850 (BA;US)
See Waters, B.J., 14:47557
Mitchell, W.J., *See* Agarwal, P.K., 14:46870
Mitomo, Shouichi, *See* Nakamura, Yoshiteru, 14:47015
Mitroy, J., Differential cross sections and Stokes parameters for electron-magnesium scattering, 14:48257 (R;AU)
Electron scattering from sodium at intermediate energies, 14:48247 (R;AU)
Mitterschiffthaler, C., *See* Bauer, P., 14:48264
Mizin, V.M., *See* Tomilova, L.G., 14:47504
Mizumoto, Motoharu., *See* Hasegawa, Kazuo, 14:47829
Modica, L.G., Flexible Regional Emissions Data System (FREDS) documentation for the 1985 NAPAP (National Acid Precipitation Assessment Program) emissions inventory. Final report, 14:47969 (R;US)
Moeller, M.P., The impact of fuel cladding failure events on occupational radiation exposures at nuclear power plants, 14:47155 (BA;US)
Moen, I.O., *See* Mackay, D.J., 14:47655
Moesslacher, B., *See* Majerotto, W., 14:48569
Mohr, C.L., *See* Tollefson, D.A., 14:47113
Mohr, D.L., *See* Starr, T.L., 14:47401
Molochnikov, L.S., *See* Radionov, B.K., 14:47503
Monkhouse, P., *See* Schwarzwald, R., 14:47661
Monnot, D.R., *See* Van Deusen, L.C., 14:47003
Montoya, N.I., *See* Paisley, D.L., 14:47846
Moody, N.R., *See* Walston, W.S., 14:47381
Mook, H.A., [Neutron scattering experiments on high-temperature superconducting materials]: Foreign trip report, September 13, 1988–October 4, 1988, 14:48533 (R;US)
Moore, C., *See* Chidume, C.E., 14:48548
Moore, D., Pilot-scale HCl control by dry alkaline injection for emissions from refuse incinerators. Technical report, 14:47946 (R;US)
Moore, K.J., *See* Brand, G.F., 14:48637
Moore, L.M., *See* Reed, R.P., 14:47444
Moore, S.B., *See* Botts, J.A., 14:48045
Morales, W., *See* Mori, S., 14:47543
Moran, B., *See* Hoover, W.G., 14:48280
Moreland, W.M., Environmental sampling technician training program, 14:46942 (RA;US)
Morgan, D., An analysis of the behavior of non-slagging, coal fired, cyclone combustors using a phenomenological model, 14:46859 (BA;US)
Morgan, D.R., High-speed parallel-processing networks for advanced architectures, 14:48720 (R;US)
Morgan, H.S., Computed and measured responses of a thick-walled hollow cylinder of salt subjected to both homogeneous and inhomogeneous loading, 14:46983 (R;US)
Morgan, W.C., *See* Gray, W.J., 14:46978
Mori, S., Degradation and crosslinking of perfluoroalkyl polyethers under X-ray irradiation in ultrahigh vacuum, 14:47543 (R;US)
Mori, Y., *See* Shimizu, H., 14:48295
Moriarty, J.A., *See* Hoover, W.G., 14:48280
Moriuchi, Shigeru, Discussion on emergency aerial survey system for practical use. Survey technique, system, operation and management, 14:47961 (R;JP;In Japanese)
Morley, C., Photolytic perturbation method to investigate the kinetics of hydrocarbon oxidation near 800 K, 14:47621 (BA;US)
Morosin, B., *See* Venturini, E.L., 14:47404
Morris, C.E., Shock induced dissociation of polyethylene, 14:47433 (R;US)
Morris, T.W., *See* Love, W.A., 14:47839
Morrison, D., *See* Chapman, C.R., 14:48192
Morse, D.H., *See* Pontau, A.E., 14:47480
Mortazavi, M.A., *See* Kowel, S.T., 14:47849
Mortensen, G.F., *See* Morris, C.E., 14:47433
Mosbacher, R., Research and development in biotechnology-related industries in Japan (1989), 14:48092 (R;US)
Moskovkin, A.S., *See* Sidorov, A.A., 14:47499
Moss, J.B., Flowfield modeling of soot formation at elevated pressure, 14:47573 (BA;US)
Mossman, B.T., *See* Sonich-Mullin, C., 14:48064
Motoya, K., *See* Torikachvili, M.S., 14:47330
Moulton, D.S., *See* Ryan, T.W. III, 14:46826
Moussa, N.A., *See* Johnson, A.M., 14:46901
Mozzhukin, E., *See* Burmeister, M., 14:47636
Mtingwa, S.K., B factory via conversion of 1 TeV electron beams into 1 TeV photon beams, 14:48324 (R;US)
Mudrakovskij, I.L., *See* Radionov, B.K., 14:47503
Mueller, M., *See* Gerstenmayer, E., 14:48344
Mueller, R., *See* Matthies, H., 14:47069
Mukunda, H.S., *See* Lakshmisha, K.N., 14:47676
Mulford, L.A., *See* Taylor, J.S., 14:48038
Mulleavy, T., Radiation protection training then and now, 14:47181 (J;US)
Mullens, J.A., *See* Broadaway, E.R., 14:48722
Muller, R.A., Astrophysical implications of periodicity, 14:48205 (RA;US)
Munekata, H., *See* Bleuse, J., 14:47413
Mungal, M.G., *See* Broadwell, J.E., 14:47587
Murali, A.V., *See* Koeberl, C., 14:48199
Muratbekov, M.B., *See* Parfent'ev, V.A., 14:47542
Murayama, Motohide, Fractal-like character of flamelets in turbulent premixed combustion, 14:47584 (BA;US)
Murphy, J.B., X-ray lithography sources: A review, 14:47800 (R;US)
Murphy, M.J., Reports published by the Gas Research Institute in the area of residential/commercial appliances and space conditioning: bibliography and abstracts. Update through 1988, 14:46917 (R;US)
Murphy, T.D., *See* Lodde, G.M., 14:47177
Murphy, W.M., Calculations of geochemical mass transfer as a function of temperature and time, 14:48167 (RA;US)
Murr, L.E., Fundamental and applied studies of explosively fabricated high-temperature superconducting fixtures. Quarterly technical report, 1 September-31 November 1988, 14:47386 (R;US)
See Carpenter, J.A. Jr., 14:47373
Murray, R.W., *See* Geng, L., 14:47535
Murray, S.B., *See* Mackay, D.J., 14:47655
Mushnikov, V.N., Transmutation process simulation in silicon during mean energy proton irradiation, 14:48513 (RA;SU;In Russian)
Musolino, S.V., The Department of Energy response to TMI [Three Mile Island], 14:47188 (J;US)
Myrabo, L.N., Transatospheric laser propulsion: Final report, 14:47279 (R;US)

N

Nagami, Masayuki and oth, *See* Kamada, Yutaka, 14:48654
Nagao, G., Divergences and involution-dependent constants, 14:48422 (J;US)
Nagaoka, Toshi, *See* Moriuchi, Shigeru, 14:47961
Nagasaka, R., *See* Schipperijn, F.W., 14:47309
Nagase, F., *See* Deeter, J.E., 14:48187
Nagata, A., 3-D resistive MHD simulation analysis of field reversal control in the reversed field pinch, 14:48651 (R;JP)
Nagda, N.L., *See* Koontz, M.D., 14:47952

Nagle, D.E., *See* Haines, T.J., 14:48183
Nagy, G., *See* Fogel, M.B., 14:47872
Nahnhauer, R., Recent results on coherent and incoherent particle production in ν-nucleus interactions below 30 GeV, 14:48306 (RA;PL)
Naito, T., *See* Anderson, J.L., 14:47166
See Yamanishi, T., 14:48700
Naito, Yoshitaka, *See* Nishio, Gunji, 14:46931
See Ogino, Teruhisa, 14:47109
Nakagawa, Hidetoshi, *See* Yamaguchi, Hiroshi, 14:47811
Nakagawa, T., *See* Shimizu, H., 14:48295
Nakamura, Haruto, Generation of radioactive wastes and the management, 14:46967 (R;JP;In Japanese)
Nakamura, Hideo, *See* Kumamaru, Hiroshige, 14:47095
Nakamura, Yoshiteru, Reconstruction of Co-60 Irradiation Facility No.1, 14:47015 (R;JP;In Japanese)
Nakanishi, C., Contribution to the study of the chemical effects of the (n, γ) reaction on copper N-benzoyl N-phenyl hydroxylaminate and copper N-benzoyl N-(o) Tolyl hydroxylaminate, 14:47547 (R;BR;In Portuguese)
Nakao, Ken-ichi., *See* Hosoya, Akio, 14:48576
Nakashima, T., *See* Imada, K., 14:48093
Namazian, M., Near-field instantaneous flame and fuel concentration structures, 14:47592 (BA;US)
See Schefer, R.W., 14:47614
Namboodiri, M.N., Multifragmentation and fission in the reactions Nb + Au and Fe + Au at 50 to 100 MeV/A, 14:48460 (R;US)
Nanni, V., *See* Gadomski, A.M., 14:47111
Naraghi, M.H.N., Three dimensional thermal analysis of rocket thrust chambers, 14:47754 (R;US)
Narayan, J., *See* Pennycook, S.J., 14:47457
See Ravindra, N.M., 14:47406
Narayan, R., MM & T for linear resonant cooler. Volume 1. Final report, October 1984-September 1986, 14:47712 (R;US)
Naruse, Y., *See* Ashibe, K., 14:48702
See Yamanishi, T., 14:48700
Nassalski, J., Search for higher twist effects in hadronic distributions from μp interactions, 14:48313 (RA;PL)
Nataranjan, K., *See* Burmeister, M., 14:47636
Natesan, K., Alloy and coating development for coal gasification applications, 14:46828 (BA;US)
Alloy performance in coal gasification environments, 14:47378 (BA;US)
See Baxter, D.J., 14:47385
See Park, J.H., 14:47388
Nath, S., *See* Shimizu, H., 14:48295
Nave, S.E., Magnetic measurements of the transuranium elements: Progress report, January 1, 1989–December 31, 1989, 14:47350 (R;US)
Nazarov, M.A., *See* Koeberl, C., 14:48199
Nazikian, R., *See* Howard, J., 14:48611
See Sharp, L.E., 14:48617
Neau, E.L., *See* Vandevender, J.P., 14:48692
Nebieridze, Ts.M., *See* Diasamidze, Eh.M., 14:47367
Nechitajlov, S.B., *See* Dudareva, A.G., 14:47515
Nedelcheva, N.P., *See* Bilenky, S.M., 14:48337
Nedelik, A., *See* Schmidt, W., 14:47808
Neerven, W.L. van, Radiative corrections in two-photon physics, including effects from non-peripheral diagrams, 14:48330 (RA;PL)
Negus, P.J., *See* Bonvin, E., 14:48292
Nehrir, M.H., *See* Smith, J.R., 14:47077
Neill, P.H., *See* Winans, R.E., 14:46832
Neimark, L.A., The microstructural and microchemical characterization of samples from the TMI-2 core, 14:47165 (J;NL)
Neklyudov, I.M., *See* Arbuzov, V.L., 14:47361
See Mushnikov, V.N., 14:48513
See Tolstolutskaya, G.D., 14:47369
See Volkov, E.D., 14:47368
Nelson, J.B., Effect of geometry on thermal aging behavior of Celion/LARC-160 composites, 14:47438 (R;US)
Nes, O.M., *See* Fossheim, K., 14:47402
Ness, K.F., *See* Robson, R.E., 14:48266
Neubauer, J., *See* Hawliczek, R., 14:48109
Neulicht, R.M., Hospital incinerator operator training course. Volume 1. Student handbook. Final report, 14:47948 (R;US)
Hospital incinerator operator training course. Volume 2. Presentation slides. Final report, 14:47949 (R;US)
Newby, R., *See* Robertson, A., 14:47074
Newell, A., *See* Gupta, A., 14:48714
Newell, R.I.E., Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (North and Mid-Atlantic): Blue mussel, 14:48015 (R;US)
Newell, T.P., MOBILE4 emission factor model: source code (one version mixed case, one version upper case), input files for example runs, and high-altitude area I/M credits (for microcomputers). Model, 14:47316 (R;US)
Newman, K.A., *See* Voorhees, L.D., 14:46999
Newmark, R.L., *See* Hearst, J.R., 14:47897
Newton, J.O., Nuclear fission induced by heavy ions, 14:48464 (R;AU)
Pre-scission particle and gamma-ray emission in heavy-ion induced fission, 14:48428 (R;AU)
Neynaber, R.H., Low-energy atomic collisions. Final scientific report, 1 June-30 September 1980, 14:48243 (R;US)
Ng, W.C., *See* Antinone, R., 14:47841
Nguyen, Q.T., Chemical Mass Balance (CMB) Receptor Model (Version 6.0) (for microcomputers). Model-Simulation, 14:47935 (R;US)
Nichols, D.K., Heavy ion induced single event phenomena (SEP) data for semiconductor devices from engineering testing, 14:47437 (R;US)
Nielsen, D.E. Jr., Resistive block methods for electrostatic field solutions with internal elements, 14:48578 (R;US)
See Rambo, P.W., 14:48663
Nielsen, P.E., *See* Mavko, B.B., 14:46913
Niessen, W. von, *See* Frost, L., 14:48252
See Grisogono, A.M., 14:48254
See Minchinton, A., 14:48248
Nigorikawa, Kazuyuki., *See* Yamaguchi, Hiroshi, 14:47811
Nikitin, A.V., *See* Volkov, E.D., 14:47368
Nikkari, E., *See* Huovinen, P., 14:47075
Nikolenko, Yu.M., *See* Karasev, V.E., 14:47509
Niksa, S., Modeling the devolatilization behavior of high volatile bituminous coals, 14:46852 (BA;US)
Niland, R.A., *See* Cramer, N.F., 14:48632
Nilson, R., Simultaneous modeling of dynamic ground motion and fluid flow in hydrofractures, 14:47876 (RA;US)
See Hudson, B., 14:47900
See Rimer, N., 14:47871
Nilson, R.H., Fickian filtering of cavity gases rising through a fractured permeable overburden, 14:47905 (RA;US)
See Griffiths, S.K., 14:47875
See Peterson, E.W., 14:47906
See Rimer, N., 14:47874
Nima, Shuji, Zero mode and modular invariance in string on non-abelian orbifold, 14:48378 (RA;JP)
Ninesteel, R., *See* Kamp, G., 14:47218
Nishio, Gunji, Development of the computer code TRANS-ACE for analysing radioactive materials transport in reprocessing plants under accidental conditions, 14:46931 (R;JP;In Japanese)
Safety demonstration test on solvent fire in fuel reprocessing plant, 14:46932 (R;JP;In Japanese)
Nishio, Satoshi, *See* Shinya, Kichiro, 14:48686
Niu, C.M., Preparation and properties of La(2-x)AxCuO(4-y) where A = Pb,Cd. Technical report, 14:47387 (R;US)
Niu, K., *See* Kono, M., 14:47303
No, S.Y., *See* Morgan, D., 14:46859
Noack., *See* Berg, 14:46886
Noel, S.D., *See* Deupree, R.G., 14:47912
Noguchi, H., *See* Yoshio, M., 14:47206
Nojiri, Shin-ichi, Pre-geometrical field theory of open string, 14:48376 (RA;JP)
Nomaguchi, T., Spark ignition of methane and methanol in ozonized air, 14:46916 (BA;US)
Nonomiya, Iwao, Vectorization of nuclear codes 88-1. SRAC, CITATION, TWOTRAN-II, COREBN, CITATION-FBR, 14:47104 (R;JP;In Japanese)

Noorman, J.T., *See* Evans, P.J., 14:47011
Northcliffe, L.C., Study of neutron-proton interaction in the 300-700 MeV energy region: Progress report, September 1988–August 1989, 14:48298 (R;US)
See Shimizu, H., 14:48295
Noskova, M.P., *See* Radionov, B.K., 14:47503
Nosonovich, A.A., *See* Pilipenko, A.T., 14:47494
Noto, Takashi, *See* Kawaguchi, Osamu, 14:46851
Noviello, C., *See* Cavaliere, A., 14:47470
Novozhilov, V.Yu., Effective QCD chiral Lagrangian for pions and vector mesons and hidden local symmetry, 14:48326 (R;XA)
Nowak, G., *See* Zaiss, F., 14:48115, 14:48116
Nowotny, R., PC-supported measuring data recording and flow planning in radiological quality assurance, 14:48106 (RA;AT;In German)
See Wergles, K., 14:47474
Nunno, T.J., Development of site remediation technologies in European countries, 14:46994 (RA;US)
Nygren, E., *See* Aziz, M.J., 14:47458

O

O'Brien, D.M., *See* Cooper, T.C., 14:47942
O'Brien, G.K., *See* Arthur, M.F., 14:47978
O'Handley, R.C., *See* Grant, N.J., 14:47327
O'Rourke, P.E., Computerized procedure for preparation of secondary standards, 14:47472 (R;US)
O'Rourke, P.J., *See* McKinley, T.L., 14:47311
Obenshain, F.E., [Data acquisition of WA80 calorimeters with ^{32}S beams]: Foreign trip report, September 11, 1987–October 13, 1987, 14:47834 (R;US)
[Nucleus-Nucleus Collisions]: Foreign trip report, June 6, 1988–June 21, 1988, 14:48477 (R;US)
See Young, G.R., 14:48444
Oberguggenberger, M., *See* Embacher, G., 14:48405
Oberhummer, H., Reaction rates in cold fusion, 14:48676 (RA;AT;In German)
See Bach, B., 14:48677
Oda, K., *See* Ohtani, S., 14:48516
Odajima, Kazuo, *See* Tamai, Hiroshi, 14:48653
Odar, F., *See* Golden, D.W., 14:47136
Ogasawara, R., Atomic and molecular database for fusion, 14:48743 (R;JP;In Japanese)
Ogawa, Toshihide, *See* Tamai, Hiroshi, 14:48653
Ogino, Teruhisa, Nuclear criticality of fuel assembly having infinite multiplication factor less than unity, 14:47109 (R;JP;In Japanese)
Ogunniyi, J.F., On averaged force acting on a particle in H.F electromagnetic field, 14:48588 (R;XA)
Ohnemus, J., *See* Barger, V., 14:48360
Ohnuma, H., *See* Shimizu, H., 14:48295
Ohsumi, K., *See* Ando, M., 14:47817
Ohtani, S., Secondary electron emission from a metal surface bombarded by slow multiply charged ions, 14:48516 (R;JP)
Oikawa, Testukuni, Data book of the component failure rate stored in the RECORD, 14:47106 (R;JP;In Japanese)
Okajima, S., *See* Kawakami, T., 14:47680
Okamoto, Sunao, Development of advanced technology for scientific research, 14:47240 (R;JP;In Japanese)
Okopinska, A., Optimized perturbation series for the effective potential in PHI^4 field theory, 14:48397 (RA;PL)
Oldenborg, R.C., *See* Wantuck, P.J., 14:47627
Olechowski, M., Spontaneous parity breaking by quantum corrections, 14:48328 (RA;PL)
Oliver, B.N., *See* Geng, L., 14:47535
Oliver, R.D., *See* Hawkins, W.L., 14:47891
Olsen, D.K., [Design of synchrotron/cooler/storage rings]: Foreign trip report, June 4, 1988–June 17, 1988, 14:47819 (R;US)
Olsher, R.H., Alpha survey instruments, 14:47153 (BA;US)
Olson, C.G., *See* Arko, A.J., 14:48531
Olson, G.J., Recent progress in coal bioprocessing research in the United States, 14:46797 (RA;US)
Olson, J.R., *See* Barsotti, D.A., 14:48067
Olson, S.L., Near-limit flame spread over a thin solid fuel in microgravity, 14:47644 (BA;US)
Omori, A., *See* Kashiwagi, T., 14:47654
Ondrejcin, R.S., Flat plate heat exchangers for the new production reactor, 14:47122 (R;US)
Ondrias, M.R., *See* Crawford, B.A., 14:47022
Onogi, Tetsuya., *See* Ishibashi, Nobuyuki, 14:48367, 14:48413
Ooguri, Hirosi, *See* Eguchi, Tohru, 14:48363
Opalev, O.A., *See* Volkov, E.D., 14:47368
Ophel, T.R., *See* Catford, W.N., 14:48446
See Orr, N.A., 14:48441
Oppenheim, A.K., *See* Lucas, D., 14:47684
See Lutz, A.E., 14:47686
Oran, E.S., *See* Patnaik, G., 14:47671
Orloff, L., *See* Delichatsios, M.A., 14:47648
Orphan, V.J., *See* Alvar, K.R., 14:47730
Orr, N.A., Observations of ^{20}N via the heavy-ion transfer reaction $^{48}Ca(^{18}O,^{20}N)^{46}Sc$, 14:48441 (R;AU)
Reaction studies of the neutron-rich nuclei $^{22,23}F$, 14:48442 (R;AU)
See Catford, W.N., 14:48446
Osborn, J., Summary, retrospect, and evolution of mobile remote systems, 14:47194 (J;US)
Osborne, P.E., *See* Bostick, W.D., 14:46968
Osucha, D.C., *See* Stewart, R.C., 14:46975
Otlet, R., Studies of environmental radioactivity in Cumbria. Pt. 13. Measurements of carbon-14 in tree rings from trees growing in the Sellafield area, 14:47959 (R;GB)
Otto, R., Preparation of radioactive labelled compounds Pt.1. ^{82}Br labelled organic bromine compounds, 14:47545 (R;FR;In French)
Preparation of radioactive labelled compounds. Pt. 2. ^{82}Br labelled organic bromine compounds by isotopic exchange, 14:47546 (R;FR;In French)
Oury, F.X., Energy analysis of large-scale crop farms: impact of energy crisis and future prospects, 14:47287 (R;FR;In French)
Ovchinnikov, I.V., *See* Galimov, R.M., 14:47487
Ovchinnikova, N.A., *See* Tomilova, L.G., 14:47504
Ovrut, B.A., 16/16, N=1 supergravity: the low energy limit of the superstring, 14:48564 (RA;PL)
E_6 symmetry breaking in the superstring theory, 14:48362 (RA;PL)
Owen, P.T., *See* Voorhees, L.D., 14:46999
Ozhigov, L.S., *See* Mushnikov, V.N., 14:48513
Ozturk, N., Electronic stopping power of ions in solids, 14:48529 (J;NL)

P

Padula, S.S., Pion interferometry of O+Au at 200 AGeV, 14:48486 (J;NL)
Pageman, R.C., *See* Shultz, S.M., 14:46890
Paige, F.E., Hermeticity requirements at SSC [Superconducting Super Collider], 14:48290 (R;US)
Pileup at the SSC [Superconducting Super Collider], 14:48291 (R;US)
Paisley, D.L., Interferometry and high speed photography of laser-driven flyer plates, 14:47846 (R;US)
Paisner, J.A., *See* Bass, I.L., 14:47748
Pakhomov, V.I., *See* Kirilenko, V.V., 14:47512
Palau, G. L., Criticality prevention during postaccident decontamination of TMI-2 [Three Mile Island Unit 2] plant systems, 14:47196 (J;US)
Palazotto, A.N., *See* Fawaz, S.A., 14:47412
Palmer, H.E., *See* Lyon, M., 14:47837
Palmetshofer, L., *See* Fromherz, T., 14:47840
See Reisinger, J., 14:47429
Pankl, C., *See* Abt, R., 14:47423
Paoloni, F.J., *See* Evans, P.J., 14:47011
Papke, J.B., *See* Dalbeck, B.W., 14:47250
Parashar, D., *See* Mishra, S.C., 14:48550
Parcher, J.F., *See* Geng, L., 14:47535
Parfent'ev, V.A., Application of ESR technique and low-temperature radiation chemistry to determine the number of water molecules in a hydrate shell of dissolved substance, 14:47542 (RA;SU;In Russian)

Parisot, M., Staircase-shaped test phantom for control of image quality in veterinary medicine, 14:48105 (RA;AT;In German)
Park, J.H., Transport properties of thermally grown Cr_2O_3, 14:47388 (R;US)
Park, Y.S., MeV implantation studies in LPE (liquid phase epitaxy)-grown GaAs and InP. Final report, 1 October 1987-31 March 1989, 14:47411 (R;US)
Parker, R.D., Symmetry breaking bifurcations of a current sheet, 14:48584 (R;AU)
Parker, S.F., *See* Lewellen, W.S., 14:47957
Parks, C.V., Criticality analysis support for TMI-2 [Three Mile Island Unit 2] fuel removal operations, 14:47195 (J;US)
Parpiev, N.A., *See* Shodiev, U.M., 14:47489
Parr, D.M., *See* Gutmark, E., 14:47581
Parr, T.P., *See* Gutmark, E., 14:47581
Parsons, R., *See* Newell, T.P., 14:47316
Pascual, R., *See* Grisogono, A.M., 14:48254
Passmore, M.E., Extent and trend of nitrate contamination in Region III: The Coastal Plain and Piedmont Province. Technical report, 14:48034 (R;US)
Pasternak, M.P., High pressure ^{129}I Moessbauer studies of GeI_4 molecular crystals, 14:48518 (R;US)
Patarcity, J.M., *See* Smith, D.M., 14:47984
Patch, D.F., Recent material test data and material response models for damage in tuff and grouts, 14:47886 (RA;US)
Pate, D.J., *See* Welch, K.M., 14:47804
Patel, Y., *See* Sonich-Mullin, C., 14:48064
Pathiyil, J., Experimental area power monitoring during shutdown, 14:47785 (R;US)
Patkos, A., *See* Frei, Z., 14:48416
Patnaik, G., Detailed numerical simulations of cellular flames, 14:47671 (BA;US)
Paton, R.F., *See* Bradbury, P., 14:46943
Patterson, J.D., Electron mobility in mercury cadmium telluride, 14:47442 (RA;US)
Patterson, P.M., High temperature study of the reaction of $O(^3P) + NH_3$, 14:47482 (R;US)
Patterson, R.P., *See* Heagle, A.S., 14:48153
Pattipati, K.R., BM/C(3) algorithm mapping onto concurrent processors. Final report, May-December 1987, 14:48719 (R;US)
Patton, H.J., Proceedings of the DOE/LLNL symposium on Explosion-Source Phenomenology, 14:47915 (R;US)
Paul, P.J., *See* Lakshmisha, K.N., 14:47676
Paulikas, A.P., *See* Arko, A.J., 14:48531
Paulsen, P.E., *See* Banks, B.A., 14:47439
See Rutledge, S.K., 14:47033
Pavelek, M.D. II, Operations and achievements of remote equipment at TMI-2 [Three Mile Island Unit 2], 14:47191 (J;US)
Pavich, T.A., *See* Khomenko, V.S., 14:47508
Pavlovsky, O.A., *See* Ilin, L.A., 14:47128
Peaple, L.H.J., Measurement of the ISO series of filtered radiations, 14:47820 (R;GB)
Pearton, S.J., *See* Mikkelsen, J.C., 14:47450
Pecherin, A.M., Formation of strain martensite in 07Kh18N9 and 03Kh16N9M2 steels and radiation-induced structure-phase transformations, 14:47364 (RA;SU;In Russian)
Pecson, F.A., *See* Ragland, K.W., 14:46868
Pedersen, T.F., *See* Curvers, A., 14:47067
Peery, K.M., 3D (three-dimensional) Navier-Stokes flow analysis for a large-array multiprocessor. Final technical report, 14 September 1988-29 February 1989, 14:48283 (R;US)
Peled, E., Advanced calcium-thionyl chloride high-power battery. Final report, 23 December 1987-22 December 1988, 14:47204 (R;IL)
Pellegrini, C., *See* Wang, X.J., 14:47799
Pellizzari, E.D., *See* Barsotti, D.A., 14:48067
Peltola, H., *See* Leden, L., 14:47280
Peng Gongwen., *See* Tian Decheng, 14:48501
Peng, J.L., Superconductivity and magnetic scattering in the $Nd_{2-x}Ce_xCuO_{4-\delta}$, 14:48535 (R;US)
Pennycook, S.J, *See* Mikkelsen, J.C., 14:47450
Pennycook, S.J., The role of trapped interstitials during rapid thermal annealing, 14:47451 (BA;US)
Transient enhanced diffusion and gettering of dopants in ion implanted silicon, 14:47457 (BA;US)
Perez-Davis, M.E., Mars manned transportation vehicle, 14:47263 (R;US)
Perini, L., *See* Bonvin, E., 14:48292
Perkins, E.H., A theoretical basis for the coupling of chemical reactions to open system processes, 14:48166 (RA;US)
Software for the computation and graphical display of intensive variable phase diagrams, 14:48170 (RA;US)
Perkins, L., Domain decomposition for partial differential equations, 14:48736 (R;US)
Perkins, M., TOXLEARN: Microcomputer-based training for TOXLINE. Software, 14:48114 (R;US)
Perkins, M.T., Micropore diffusion in coal chars under reactive conditions: Quarterly technical progress report, 15 December 1988–15 March 1989, 14:46822 (R;US)
Perrino, C., *See* Hering, S.V., 14:47937
Perry, A.J., Fast anisotropic etching of silicon by SF_6 in an inductively coupled plasma reactor, 14:48505 (RA;AU)
Plasma diffusion in an inductively coupled RF plasma etching system, 14:48606 (RA;AU)
Perry, R.A., *See* Tully, F.P., 14:47638
Perry, R.T., *See* Wilson, W.B., 14:48474
Pershing, D.W., *See* Chen, S.L., 14:46874
See Slaughter, D.M., 14:46876
Persoff, P., A laboratory investigation of foam flow in sandstone at elevated pressure, 14:46894 (BA;US)
Persson, M., Nonlinear simulations of wall locking and tokamak disruptions, 14:48630 (RA;AU)
Pertermann, D., Regular lattices as saddle-points of a two dimensional random lattice theory, 14:48400 (RA;PL)
Pervez, S., *See* Akhtar, K.M., 14:47120
See Younus, M., 14:47117
Petarca, L., *See* Tognotti, L., 14:46862
Peter, M., Positron annihilation radiation in high-temperature superconductors, 14:47827 (RA;AT;In German)
Peterka, D., The effect of pore fluid diffusion in grout spheres, 14:47883 (RA;US)
Peters, N., Premixed combustion in a vortex, 14:47578 (BA;US)
See Effelsberg, E., 14:47598
Peters, R.W., *See* Martino, L.E., 14:47214
Peters, W.A., *See* Ko, G.H., 14:46853
Peterson, E., *See* Hudson, B., 14:47900
Peterson, E.W., Dispersion of contaminant during oscillatory gas-motions driven by atmospheric pressure variations, 14:47906 (RA;US)
See Nilson, R.H., 14:47905
Peterson, H.K., *See* Vallem, R.J., 14:47174
Peterson, T.B., Water-pollution abatement expenditures in the Wisconsin paper industry. Technical report, 14:48037 (R;US)
Peterson, T.W., *See* Scotto, M.V., 14:46866
Petrakovskaya, Eh.A., *See* Zeer, Eh.P., 14:47525
Petraschek, D., Neutron phase shift near a dynamic Bragg reflection, 14:48567 (RA;AT;In German)
Petre, R., *See* Teske, R.G., 14:48188
Petricevic, V., Nonradiative relaxation and laser action in tunable solid state laser crystals. Final technical report, 1 September 1987-31 December 1988, 14:47745 (R;US)
Petrov, V.N., *See* Israel, Y.A., 14:47126
Petrusenko, Yu.T., *See* Arbuzov, V.L., 14:47361
Petrzilka, V., Nonlinear reflection coefficient of the fast magnetoacoustic wave, 14:48647 (RA;CS)
On lower hybrid wave scattering by plasma density fluctuations, 14:48646 (RA;CS)
Pettit, D.R., *See* Forest, C.A., 14:47858
Petty, J.L., Total quality management – Remedial actions planning program, 14:47005 (R;US)
Peyre, C.H., *See* Bouniol, P.E., 14:47223
Peyton, G.R., Feasibility of adding TCE [trichloroethylene] still area and Northeast area plumes to ultraviolet radiation, ozone, hydrogen peroxide groundwater treatment plant, Department of Energy Kansas City Plant, 14:48025 (R;US)
Pfafman, T., *See* Silver, E., 14:47850
Pham Quang Hung, Standard electroweak model and beyond: a review, 14:48340 (RA;PL)

Pham, V.T., Temperature-dependent enantiospecificity of secondary alcohol dehydrogenase from Thermoanaerobacter ethanolicus, 14:47530 (J;US)
Phaneuf, R.A., [Carbon and oxygen collision data for fusion plasma research]: Foreign trip report, May 7–May 15, 1988, 14:48658 (R;US)
Pheiffer, T., *See* Nunno, T.J., 14:46994
Phillips, J.C., How can materials theory benefit from supercomputers and vice versa?, 14:47324 (RA;US)
Phillips, M.H., *See* Levy, R.P., 14:48112
Phillips, R.J.N., *See* Barger, V., 14:48360
Phillips, R.S., *See* Pham, V.T., 14:47530
Phillips, S.J., Engineered surface barriers for waste disposal sites: lysimeter facility design and construction, 14:46946 (RA;US)
Phuoc, T.X., Laser pyrolysis of single coal particles in an electrodynamic balance, 14:46854 (BA;US)
Picard, G., *See* Mestries, J.C., 14:48138
Pierre, B., *See* Finkbeiner, F., 14:47281
Pierre, D.A., *See* Smith, J.R., 14:47077
Pietscher, J., *See* Boehm, H., 14:47572
Pilat, M., *See* Moore, D., 14:47946
Pilipenko, A.T., Different-ligand complexes of some d-metals with monovacant heteropolyanions, 14:47523 (RA;SU;In Russian)
ESR study of aquahumate complexes of iron (3), copper (2), manganese (2), vanadium (4), and chromium (3), 14:47494 (RA;SU;In Russian)
See Trachevskij, V.V., 14:47519
Pillmayr, N., Calorimetric and magnetic properties in uranium - intermetallic compounds, 14:47353 (RA;AT;In German)
See Hilscher, G., 14:47357, 14:47425
Pincosy, P.A., *See* Cutting, J.L., 14:47768
Pink, P.N., Reporting environmental data of known quality, 14:48742 (R;US)
Pinski, F.J., *See* Allen, P.B., 14:48536
Piquet, O., Anomalies in gauge and supersymmetric gauge theories, 14:48401 (RA;PL)
Pisarski, R.D., Renormalized fermion propagator in hot gauge theories, 14:48421 (J;NL)
Pitarke, J.M., Electron density fluctuations induced by ion clusters in condensed matter, 14:48527 (J;NL)
Pitt, W.W., *See* Bouniol, P.E., 14:47223
Pitts, W.M., Assessment of theories for the behavior and blowout of lifted turbulent jet diffusion flames, 14:47611 (BA;US)
Pitz, W.J., Autoignition chemistry of N-butane in a motored engine, 14:47021 (B;US)
See Droege, M.W., 14:47018
See Westbrook, C.K., 14:47616, 14:47619
Pitzer, K.S., *See* Schreiber, D.R., 14:47760
Pizzitola, V., *See* Walden, T.L., 14:48119
Plankenhorn, L.J., Carcinogenicity of azo dyes: Acid Black 52 and Yellow 3 in hamsters and rats. Volume 2. Technical report (Final), 14:48148 (R;US)
Plasil, F., Fluctuations in transverse energy and multiplicity, energy densities, and neutral pion spectra in nucleus-nucleus collissions at 200 GeV/nucleon, 14:48458 (R;US)
[Lead beams at CERN]: Foreign trip report, April 14, 1988–April 29, 1988, 14:47797 (R;US)
[Nucleus-nucleus collisions]: Foreign trip report, June 5–11, 1988, 14:48476 (R;US)
[Workshop on gross properties of nuclei and nuclear excitations]: Foreign trip report, January 12–February 4, 1989, 14:48483 (R;US)
See Awes, T.C., 14:47796
See Young, G.R., 14:48444
Platner, E.D., *See* Love, W.A., 14:47839
Plato, P., *See* Miklos, J. A., 14:47176
Pletzer, A., Generalization of the Newcomb equation to Hamiltonian form, 14:48629 (RA;AU)
Plumlee, G.S., Preliminary chemical modeling of epithermal processes at Creede, Colorado: The role of fluid mixing as an ore deposition mechanism, 14:47059 (RA;US)
Pocha, M.D., *See* Druce, R.L., 14:47727
Pohlmann, K.F., Generalized ground-water sampling device matrix (journal version), 14:48032 (R;US)
Poier, E., Troubles of cardiac pacemakers due to irradiation at a linear accelerator, 14:48125 (RA;AT;In German)
See Leitner, H., 14:48110
See Stuecklschweiger, G., 14:47809
Poindexter, M.E., Engineering and economic analysis of containment area/wetlands disposal options in New York harbor. Final report, 14:48018 (R;US)
Poinsot, T., Initiation and suppression of combustion instabilities by active control, 14:47657 (BA;US)
Poletti, A.R., *See* Stuchbery, A.E., 14:48454
Polyakov, A.A., Experimental investigation of the radial fission product distribution in WWER fuel, 14:47093 (RA;XA)
Ponsolle, L., *See* Delfosse, L., 14:47558
Pontau, A.E., Ion microbeam tomography, 14:47480 (J;NL)
Pope, S.B., The stochastic flamelet model of turbulent premixed combustion, 14:47608 (BA;US)
See Haworth, D.C., 14:47588
Poplitsch, A., *See* Gruber, H., 14:47426
Poppke, H., *See* Brand, M., 14:47255
Porteous, R.K., Antenna coupling calculations for BASIL II, 14:48639 (RA;AU)
New 1D-3V spherically symmetric PIC code, 14:48268 (RA;AU)
Porter, L.H., *See* Austin, W.E., 14:47189
See Vervaet, D., 14:47192
Porter, T., *See* Lapins, A., 14:48017
Post, H.N., Photovoltaic system research status, 14:47040 (R;US)
Potter, M., *See* Haines, T.J., 14:48183
Potter, R.M., *See* Tester, J.W., 14:47056
Pottlacher, G., *See* Jaeger, H., 14:47355
Pouliot,, *See* Namboodiri, M.N., 14:48460
Pouliquen, B., *See* Dunlop, J.A., 14:47555
Poultney, R., *See* Bonvin, E., 14:48292
Pounds, J.G., *See* Gordon, B.M., 14:47461
Powell, D.C., *See* Connell, J.R., 14:47073
Powell, M.A., *See* Pyne, J.W., 14:46804
Power, J.F., *See* Stein, W.E., 14:47744
Powers, D., *See* Burson, S.B., 14:47164
Pragnell, R.J., *See* Gibbs, B.M., 14:46875
Prasad, R., *See* Khan, I.A., 14:48551
Prasolova, O.D., *See* Borisova, L.V., 14:47511
Prati, M.V., *See* Barbella, R., 14:47707
Preece, T.E., *See* Herbert, A.W., 14:47987
Pregermain, S., *See* Legrand, A.P., 14:46837
Prelec, K., Source options for RHIC, 14:47803 (R;US)
Pressl, K., *See* Abt, R., 14:47423
Prestwich, K.R., *See* Vandevender, J.P., 14:48692
Price, L., *See* Baumann, N., 14:48304
Price, W.E., *See* Nichols, D.K., 14:47437
Primus, R.J., *See* McKinley, T.L., 14:47311
Pringle, D.M., Alpha-particle decay widths of levels in ^{19}F, 14:48438 (R;AU)
See Vermeer, W.J., 14:48443
Proctor, I.D., *See* Pontau, A.E., 14:47480
Prono, J., *See* Struble, G.L., 14:47245
Proshko, V.Ya., *See* Derskij, L.S., 14:48511
Prosyolkov, V.N., *See* Polyakov, A.A., 14:47093
Proukakis, C., Medical view of the health effects of the pre-Chernobyl nuclear incidents and accidents, 14:48123 (RA;FR)
Pruess, K., *See* Persoff, P., 14:46894
Prytz, A., *See* Porteous, R.K., 14:48639
Pu, Yi Kang, Comparative study of the influence of obstacles on the propagation of dust and gas flames, 14:47695 (BA;US)
The investigation of the feature of dispersion induced turbulence and its effects on dust explosions in closed vessels, 14:47694 (BA;US)
Pugh, C.E., [Discussion of fracture mechanics and testing for reactor pressure components, Stuttgart, W. Germany, May 23–27, 1988]: Foreign trip report, 14:47107 (R;US)
[Reliability of reactor pressure components]: Foreign trip report, October 16–21, 1988, 14:47087 (R;US)
Puko, R.A., *See* Ksenofontova, N.M., 14:47520
Purdie, P.H., *See* Fletcher, J., 14:48246
Puri, I.K., *See* Smooke, M.D., 14:47674

Pyne, J.W., Enzymatic degradation of low-rank coals by a cell-free enzymatic system from coriolus versicolor, 14:46804 (RA;US)

Q

Qadir, A., On quantum effects near a black hole singularity, 14:48563 (R;XA)
Qazi, M.K., *See* Akhtar, K.M., 14:47120
Qin-Wen, ZHANG, New approach to the origin of the tektite in China, 14:48215 (RA;US)
Quarteroni, A., Domain decomposition methods for systems of conservation laws: Spectral collocation approximations. Final report, 14:48573 (R;US)
Que Hee, S.S., *See* Barsotti, D.A., 14:48067
Quealy, A., *See* Blech, R.A., 14:48732
See Cole, G.L., 14:48733
Quigley, D.R., Comparison of alkali and microbial solubilization of oxidized, low-rank coal, 14:46803 (RA;US)
Quinby-Hunt, M.S., *See* Wilde, P., 14:48214
Quinn, J.W., Summaries of papers presented at the short-wavelength coherent radiation: Generation and applications topical meeting held in Cape Cod, Massachusetts on September 26-29, 1988. Final report, 9 March 1988-1 March 1989, 14:47738 (R;US)
Quintenz, J.P., *See* Mendel, C.W. Jr., 14:48691

R

Rabitsch, H., Long-term investigation of the time dependence of radioactive cesium concentrations in human muscle tissue, 14:48127 (RA;AT;In German)
Rabitz, H., *See* Yetter, R.A., 14:47622
Rackovsky, S.R., *See* Goldstein, D.A., 14:48087
Radionov, B.K., NMR, XES, and IR-spectroscopy study of complexing ability of phosphorus-containing ionites, 14:47503 (RA;SU;In Russian)
Radke, C.J., *See* Persoff, P., 14:46894
Radousky, H.B., *See* Folkerts, T.J., 14:47405
See Peng, J.L., 14:48535
Rafferty, K.D., A materials and equipment review of selected US geothermal district heating systems, 14:47057 (R;US)
Raghunandan, B.N., Recirculating flow over a burning surface - flame structure and heat transfer augmentation, 14:47669 (BA;US)
Ragland, K.W., Coal fragmentation in a fluidized bed combustor, 14:46868 (BA;US)
Ragucci, R., *See* Cavaliere, A., 14:47470
Rahn, L.A., Measurements of nitrogen Q-branch foreign gas-broadening coefficients relevant to flames, 14:47464 (BA;US)
Rainisch, R., Using ex-core neutron detectors to estimate fuel quantities in the reactor vessel lower head, 14:47175 (J;US)
Rainwater, J.C., *See* Hanley, H.J.M., 14:47526
Rajan, K.S., *See* Lakshmisha, K.N., 14:47676
Rakitin, Yu.V., *See* Minin, V.V., 14:47490
Ram, M.S., Cyclopentane formation in the reduction of 1,5-dihaloalkanes with a nickel(I) macrocycle, 14:47023 (J;US)
Ramachandran, R.S., Forced convection heat transfer of interacting spheres, 14:47758 (J;US)
Raman, S., [International conference on applications of nuclear techniques, Crete, Greece, and visit to Utrecht, Netherlands, June 27–July 8, 1988]: Foreign trip report, 14:47835 (R;US)
[Work outline for the Japan/US actinides program]: Foreign trip report, January 17–26, 1989, 14:48436 (R;US)
Rambo, J.T., Geologic and material property combinations that adversely influence residual stress in 2-D dynamic containment calculations, 14:47878 (RA;US)
Possible relation between sonic velocity measured at the edge of a large borehole and shear failure, 14:47895 (RA;US)
See Anderson, G.D., 14:47896
Rambo, P.W., Temporal and spatial filtering remedies for dispersion in electromagnetic particle codes, 14:48663 (R;US)
Ramirez, J.J., *See* Vandevender, J.P., 14:48692
Ramsay, J.B., *See* Crane, S.L., 14:47855
Range, W.H., *See* Bonvin, E., 14:48292
Rangel, R.H., Unsteady flame propagation in a spray with transient droplet vaporization, 14:47704 (BA;US)
Rankin, W.N., Decontamination and coating of lead, 14:46955 (RA;US)
Ranta, D.E., *See* Fogel, M.B., 14:47879
Rantatalo, E., *See* Siltanen, T., 14:47276
Rao, A.K., Cooper-bessemer coal-fueled engine system, 14:47313 (BA;US)
Raridon, R.I., *See* Whealton, J.H., 14:48668
Ratnavelu, K., *See* McCarthy, I.E., 14:48255
Rauch, H., *See* Badurek, G., 14:48674
See Petraschek, D., 14:48567
Rauscher, T., *See* Bach, B., 14:48677
Ravindra, N.M., Electrical, optical and structural properties of thin SiO_2 films on Si, 14:47406 (BA;US)
Ravizza, G.E., *See* Turekian, K.K., 14:48210
Raymer, M.G., Nonlinear dynamics of broad-band lasers: Progress report, September 1, 1988–August 31, 1989, 14:47741 (R;US)
Razvina, T.I., *See* Ksenofontova, N.M., 14:47520
Readdy, H.P., *See* Weitkamp, W.G., 14:47806
Reams, G., *See* Vong, R., 14:47936
Rebelsky, L., *See* Torikachvili, M.S., 14:47330
Rechenberg, I., BERWIAN: Development, construction and operation of a new type of wind power plant with vortex screw focusser (phase 1), 14:47072 (R;DE;In German)
Reed, L., A research plan for coal biogasification, 14:46799 (RA;US)
Reed, L.L., *See* Hollis, D.J., 14:47870
Reed, M.H., *See* Spycher, N.F., 14:47060
Reed, N.R., Health-risk assessment of trichlorofluoromethane in California drinking water, 14:48150 (R;US)
Reed, R.A., *See* Geng, L., 14:47535
Reed, R.P., The SANDIA standard for PVDF [polyvinylidene difluoride] shock sensors, 14:47444 (R;US)
Reed, W., *See* Reed, N.R., 14:48150
Reeves, J.H., *See* Dunlop, J.A., 14:47555
Regan, P., *See* Kamp, G., 14:47218
Regge, P. de, Actual experience in burnup determination of mixed oxide fuel, 14:47477 (RA;XA)
Reginato, L.L., *See* Devoto, R.S., 14:48693
Rehmat, A., *See* Robertson, A., 14:47074
Rehn, L.E., Anomalous ion-channeling behavior across the superconducting transition in high-T_c materials, 14:48497 (R;US)
Rehwald, W., *See* Ambach, W., 14:47992
Reich, S., *See* Banks, H.T., 14:48574
Reichle, D.E., Research organization: Environmental Sciences Division, Oak Ridge National Laboratory, 14:47985 (R;US)
[Visit to the La Selva Biological Station, Costa Rica]: Foreign trip report, February 28–March 5, 1988, 14:47974 (R;US)
Reid, S., *See* Struble, G.L., 14:47245
Reilly, A., Combined sewer overflow: A management study. Technical report, 14:48061 (R;US)
Reilly, M.A., Emergency response planning in Pennsylvania, 14:47185 (J;US)
Reimann, M., The WECHSL-Mod2 code: A computer program for the interaction of a core melt with concrete including the long term behavior. Model description and user's manual, 14:47144 (R;DE)
Reimold, W.U., *See* Dressler, B.O., 14:48195
Reines, F., *See* Baumann, N., 14:48304
Reinovsky, R.E., *See* Lindemuth, I.R., 14:47766
Reisinger, J., Defects in H^+- and He^+-irradiated silicon, 14:47429 (RA;AT;In German)
Reisner, G., Measuring and control system for coal ploughs - development of a method for identification of the seam/rock interface. Final report, 14:46843 (R;DE;In German)
Rekos, N.F., *See* Bedick, R.C., 14:46879
Remington, B.A., *See* Namboodiri, M.N., 14:48460
Renlund, A.M., Raman spectroscopic studies of shock-compressed nitromethane and nitromethane-d_3, 14:47861 (R;US)
Rensberger, K.J., NH and CH laser-induced fluorescence in low-pressure flames: Quantum yields from time-resolved measurements, 14:47466 (BA;US)
Reposeur, T., *See* Frascaria, R., 14:48348
Rescigno, T.N., New theoretical approaches for studying electron collisions with small molecules, 14:48278 (R;US)

See Schneider, B.I., 14:48272
Reuillon, M., *See* Bastin, E., 14:47562
Reverchon, E., *See* Lignola, P.G., 14:47682
Reynolds, J.W., *See* Thomson, J.S., 14:46836
Reynolds, M.D., The applicability of investigative techniques at an abandoned landfill, 14:47981 (RA;US)
Reznichenko, Eh.A., *See* Arbuzov, V.L., 14:47361
See Igrushin, V.V., 14:47363
Ribier, B., *See* Finkbeiner, F., 14:47281
Richard, J.R., *See* Gokalp, I., 14:47710
Richardson, F.D., Health-hazard evaluation report HETA-87-300-0000, B. F. Goodrich Company, Marietta, Ohio, 14:47944 (R;US)
Ridky, J., Physics and Monte Carlo on DELPHI, 14:48317 (RA;SU)
Riehs, P., *See* Harvey, J.A., 14:48315
Rieker, T.P., Chevron layer structures in surface stabilized ferroelectric liquid crystal (SSFLC) cells filled with a material which exhibits the chiral nematic to smetic C* phase transition, 14:47432 (R;US)
Riekert, G., *See* Grotheer, H.H., 14:47626
Riemann, T., Polarization in tau-lepton production at LEP and $\sin^2\Theta_W$, 14:48355 (RA;SU)
Riess, F., *See* Dracoulis, G.D., 14:48453
Riess, R., *See* Dracoulis, G.D., 14:48456
Rimer, N., Containment analyses for the Mission Ghost cavity event, 14:47871 (RA;US)
Recent developments in hydrofracture calculations related to containment, 14:47874 (RA;US)
The effect of strain paths calculated for spherically symmetric explosions on measured damage in tuff, 14:47888 (RA;US)
See Nilson, R., 14:47876
Rimini, A., *See* Ghirardi, G.C., 14:48553
Rink, H.H., *See* Desvousges, W.H., 14:47965
Ritala, K.E., *See* Dunlop, J.A., 14:47555
Ritchie, R.H., *See* Pitarke, J.M., 14:48527
See Steuer, M.F., 14:48528
Rivera, J.E.M., Hidden regularity for a strongly nonlinear wave equation, 14:48572 (R;BR)
Rivers, M.L., *See* Gordon, B.M., 14:47461
Robb, E.V., *See* Adams, R.C., 14:47950
Robbins, G.A., *See* Winschel, R.A., 14:46818
Roberti, G., *See* Marmolino, C., 14:48174
Roberts, A.G., *See* Broadaway, E.R., 14:48722
Roberts, J.A., *See* Strachan, J.D., 14:48660
Robertson, A., Second-generation pressurized fluidized bed combustion plant conceptual design: Phase 1, Task 1, Executive summary, 14:47074 (R;US)
Robertson, I., *See* East, B.W., 14:47991
Robin, A.M., Phase I, Volume I, Program summary and PDU [process development unit] operations: Topical report, October 1987–January 1989, 14:46816 (R;US)
Robin, E., *See* Rocchia, R., 14:48206
Robinson, G.H., *See* Evans, W.J., 14:47531
Robinson, J.E., Underground storage tanks: State regulations and compliance strategies, 14:46995 (RA;US)
Robinson, P., Methodology of window thermal performance assessment techniques in the US and the UK, 14:47266 (R;GB)
Robson, R.E., Muon catalyzed fusion: effect of an electric field, 14:48266 (RA;AU)
Rocchia, R., Search for the Tunguska event in the Antarctic snow, 14:48206 (RA;US)
Rocha, C.A. da., Measurements of fusion cross section for $^{12}C + ^{63,65}$ Cu systems, 14:48448 (R;BR;In Portuguese)
Rochau, G.E., *See* Mendel, C.W. Jr., 14:48691
Rockwell, R.J., Occupational hazards of laser-material processing. Final report, 1 October 1972-31 January 1975, 14:47939 (R;US)
Rodabaugh, J.M., Disassembly and defueling of the upper core support assembly, 14:47190 (J;US)
Roddy, D.J., *See* Tinus, R.W., 14:47926
Roennberg, R., Performance of ventilation systems in residential buildings, 14:47275 (R;FI;In Finnish)
Rogers, J.A., *See* Gossett, C.A., 14:47805
Rogers, J.W. Jr., *See* Erickson, K.L., 14:47860
Rogg, B., Structures of wet CO flames with full and reduced kinetic mechanisms, 14:47663 (BA;US)
Rohay, A.C., Earthquake recurrence rate estimates for eastern Washington and the Hanford Site, 14:48162 (R;US)
Rohlfing, E.A., Resonantly enhanced multiphoton ionization for the trace detection of chlorinated aromatics, 14:47463 (BA;US)
Rohwein, G.J., *See* Vandevender, J.P., 14:48692
Roine, M., *See* Leden, L., 14:47280
Rojzen, I.I., On exclusive structure functions and inclusive hadron spectra near X=1, 14:48347 (RA;SU;In Russian)
Rolfs, C., Nuclear astrophysics: from Big Bang to supernovae, 14:48178 (RA;AT;In German)
Roman, V., Influence of pyridostigmine on the antiemetic effect of domperidone in irradiated macaques, 14:48137 (RA;FR;In French)
Romaniuk, M., Metric bag model of hadrons, 14:48335 (RA;PL)
Romanovskij, V.N., *See* Afonin, M.A., 14:47517
Rondio, E., Q^2 and W dependence of multiplicities in μ^+p scattering at 280 GeV, 14:48312 (RA;PL)
Ronney, P.D., On the mechanisms of flame propagation limits and extinguishment processes at microgravity, 14:47681 (BA;US)
Roquemore, W.M., *See* Chen, L.D., 14:47596
Rose, E.K., *See* Donnelly, I.J., 14:48610
Rose, S., Isolating a cell maximally secreting acetylcholinesterase. Annual report, 31 January 1984-30 January 1985, 14:48084 (R;US)
Rosen, I.G., *See* Banks, H.T., 14:48574
Rosenberg, T.J., *See* Singer, H.J., 14:48236
Rosner, R., *See* Deluca, E.E., 14:48189
Ross, B.A., Nuclear closed-cycle gaseous heat engine concept, 14:47101 (R;US)
Ross, B.E., *See* Diem, D.A., 14:47983
Ross, J.H., *See* Bourqeois, B.S., 14:48717
Ross, M., High pressure studies of planetary matter, 14:48227 (R;US)
Rosselet, L., *See* Bonvin, E., 14:48292
Rossotti, F.J.C., *See* Hughes, M.A., 14:47481
Roth, A.J., *See* Johnson, A.M., 14:46901
Roth, E., Progress in stable isotope analysis and new possibilities of clinical investigations, 14:48100 (R;FR)
Roth, J.R., Investigation of r-f emissions from electric-field-dominated plasmas. Final scientific report, 31 January 1980-31 March 1989, 14:48282 (R;US)
Roth, K., *See* Abt, R., 14:47423
Roth, P., *See* Burmeister, M., 14:47636
Rothe, K.E., *See* Whealton, J.H., 14:48668
Rothem, T., *See* Steward, P.H., 14:47624
Roush, T.L., *See* Gradie, J.C., 14:47898
Roussin, R.W., *See* Ingersoll, D.T., 14:48491
Rouveirolles, P., *See* Baetz, P., 14:47639
Rowcliffe, A.F., *See* Ishino, S., 14:48669
Roy, C.M., *See* Banerjee, S., 14:47100
Rozanov, V.B., *See* Kotel'nilov, S.S., 14:47810
Ruben, M.S., *See* Phillips, S.J., 14:46946
Rubenstein, E., *See* Thompson, A.C., 14:47459
Rubow, L., *See* Robertson, A., 14:47074
Rudenko, V.A., *See* Bykov, V.N., 14:47393
Rudnicki, S., *See* Giese, W., 14:48122
Ruff, M., EPA's (Environmental Protection Agency) role in nonhazardous solid-waste management on Indian land: Issues and options. Technical report, 14:47231 (R;US)
Ruggiero, A.G., Impedances and instabilities of the AGS Booster, 14:47791 (R;US)
Ruhter, P.E., Radiological conditions and experiences in the TMI-2 [Three Mile Island Unit 2] auxiliary building, 14:47169 (J;US)
Rundle, W.J., Design and performance of an optical mount using cross-flexure pivots, 14:47728 (R;US)
Ruotsalainen, R., *See* Roennberg, R., 14:47275
Russel, T.J., *See* Stein, W.E., 14:47744
Russell, D.P., *See* Wang, X.J., 14:47799
Russell, J.J., Kinetics of the reactions of chlorinated alkynes with atomic oxygen: The application of a new experimental technique, 14:47920 (BA;US)
Russell, K.F., *See* Miller, M.K., 14:48176
Russell, S.D., Double-sided coaxial laser, 14:47749 (P;US)
Russo, A.J., Thermocapillary flow in a pulsed-laser weld pool, 14:47382 (BA;US)

Russo, G., *See* Di Blasi, C., 14:47643
Russo, O.L., *See* Ravindra, N.M., 14:47406
Rutledge, S.K., Evaluation of atomic oxygen resistant protective coatings for fiberglass-epoxy composites in LED, 14:47033 (R;US)
See Banks, B.A., 14:47439
Ryan, T.W., Engine and constant volume bomb studies of diesel ignition and combustion, 14:47308 (B;US)
Ryan, T.W. III, Characterization, processing, and diesel engine evaluation of coal liquid fuels, 14:46826 (BA;US)
Ryan, U., *See* Holmberg, E., 14:48101
Rybalko, V.F., *See* Tolstolutskaya, G.D., 14:47369
See Volkov, E.D., 14:47368

S

Saastamoinen, J., Experiments on the combustion of small peat particles in an entrained-flow, isothermal furnace. Research note, 14:46883 (R;FI)
Sabharwal, A., Parallelism in rule-based systems, 14:48738 (BA;US)
Sacher, J., *See* Goiser, R., 14:47828
Sachwitz, M., *See* Riemann, T., 14:48355
Sack, T.M., *See* Stanley, J.S., 14:47479
Sadakata, Masayoshi, Development of slag-tap combustor for high intensity pulverized coal combustion, 14:46860 (BA;US)
Sadighi, I., *See* Smith, J.R., 14:47077
Saenz, J., *See* Teichert, W.P., 14:47216
Safe, S.H., *See* Barsotti, D.A., 14:48067
Safinya, C.R., *See* Rieker, T.P., 14:47432
Saied, R., A simulation with a cellular automaton for turbulent combustion modeling, 14:47586 (BA;US)
Saini, S., *See* Young, G.R., 14:48444
Saito, K., *See* Mackowski, D.W., 14:47647
Saitoh, Yoshihiro, Lorentz symmetry in the light-cone field theory of open and closed strings, 14:48373 (RA;JP)
Sakai, Kenji, Off-shell amplitude in Witten's bosonic string field theory, 14:48377 (RA;JP)
Sakai, Takeshi, *See* Sadakata, Masayoshi, 14:46860
Sakamoto, Ryuichi, *See* Moriuchi, Shigeru, 14:47961
Sakenas, C.A., *See* Sjoreen, A.L., 14:47156
Sal'nikov, Yu.I., *See* D'yachkova, T.A., 14:47521
Salam, T.F., *See* Gibbs, B.M., 14:46875
Salatino, P., The role of peripheral percolation in detachment of fines from burning carbon particles, 14:46847 (BA;US)
Samios, N.P., Future high energy heavy ion physics at Brookhaven, 14:47789 (J;NL)
Samples, S.D., *See* Coleman, G., 14:47272
Samuel, M.A., *See* Boudjema, F., 14:48325
Samuels, R., *See* Doggett, G., 14:47715
Samuelsen, G.S., *See* Cameron, C.D., 14:47773
See McDonell, V.G., 14:47469
Samways, J., *See* Cable, A.S., 14:46964
Sanchez, D.M., *See* Ko, G.H., 14:46853
Sandalls, F.J., Uptake of radiocaesium by upland herbaceous vegetation in relation to soil type, 14:47988 (R;GB)
Sandarusi, J.A., An automated flow calorimeter for heat capacity and enthalpy measurements, 14:47851 (J;US)
Sandberg, V.D., *See* Haines, T.J., 14:48183
Sanders, B.R., *See* Dwyer, H.A., 14:47703
Sanecki, J.E., *See* Neimark, L.A., 14:47165
Sangster, T.C., *See* Namboodiri, M.N., 14:48460
Sankar, J., *See* Avva, V.S., 14:47419
Sankar, S.V., Driving of axial acoustic waves by side-wall stabilized premixed flames, 14:47658 (BA;US)
Sanquer, M., *See* Boucher, B., 14:47334
Saritepe, S., *See* Michelotti, L., 14:47793
Sarofim, A.F., *See* Kang, S.G., 14:46865
See Kang, S.W., 14:46856
See Walsh, P.M., 14:46867
See Wornat, M.J., 14:46855
Sasaki, Shinobu, *See* Oikawa, Testukuni, 14:47106
Satio, Kimiaki, *See* Moriuchi, Shigeru, 14:47961
Sato, H., *See* Shimizu, H., 14:48295
Sato, Hikaru, Reducing the rank of gauge groups in orbifold compactification, 14:48415 (RA;JP)
Sato, Hitoshi, *See* Ikeshima, Yoshiaki, 14:47118
Sato, K.I., *See* Nagata, A., 14:48651
Sato, Masahiko, *See* Yamamura, Hidemasa, 14:48687
Sato, Shingo, Easy method of a neutron skyshine calculation and its application to the Japanese Hadron Project, 14:48490 (R;JP;In Japanese)
Sattar, A., *See* Akhtar, T., 14:48128
Sattler, A.R., *See* Lorenz, J.C., 14:46896
Satz, H., Quark-gluon plasma, 14:48343 (RA;AT;In German)
Saulys, A.C., *See* Love, W.A., 14:47839
Savage, M.E., *See* Mendel, C.W. Jr., 14:48691
Savill, P.S., *See* Crockford, K.J., 14:47031
Sawyer, R.F., *See* Schipperijn, F.W., 14:47309
Scanlan, R.M., *See* Kanithi, H.C., 14:47732
Schacher, J., QCD in UA2, 14:48301 (RA;PL)
Schachner, J., Irradiation planning by video digitalization, 14:48103 (RA;AT;In German)
Schadow, K.C., *See* Gutmark, E., 14:47581
Schaefer, B.E., Gamma-ray burster counterparts - Radio, 14:48230 (J;US)
Schaffarich, P., *See* Jodlbauer, H., 14:47390
Schappert, G.T., *See* Kyrala, G.A., 14:48273
Scharer, J.E., Fusion plasma theory: Task 3, Auxiliary heating in tokamaks: Progress report, [1988–1989], 14:48585 (R;US)
Schatz, G.C., *See* Dunning, T.H. Jr., 14:47262
Schauss, R.D., Application of three-dimensional computer solids modeling to TMI-2 [Three Mile Island Unit 2] defueling activities, 14:47197 (J;US)
Computer system development to support TMI-2 [Three Mile Island Unit 2] radiological controls, operations, and records management activities, 14:47178 (J;US)
Schefer, R.W., Structural characteristics of lifted turbulent-jet flames, 14:47614 (BA;US)
See Namazian, M., 14:47592
Schenkel, R., Non-destructive burnup determination of spent fuel in the framework of nuclear material safeguards, 14:47007 (RA;XA)
Schidlovsky, G., *See* Gordon, B.M., 14:47461
Schiller, P., *See* Ishino, S., 14:48669
Schipperijn, F.W., Imaging of engine flow and combustion processes, 14:47309 (B;US)
Schirber, J.E., *See* Arko, A.J., 14:48531
See Tigges, C.P., 14:48523
Schlenstedt, S., *See* Klein, M., 14:48303
Schmidt, W., Development of ancillary equipment for a linear accelerator, 14:47808 (RA;AT;In German)
See Handl-Zeller, L., 14:48108
See Hawliczek, R., 14:48109
See Wallner, G., 14:47473
Schmiedmayer, J., *See* Harvey, J.A., 14:48315
See Petraschek, D., 14:48567
Schmueser, P., HERA: the physics and the machine, 14:48311 (RA;PL)
Schnaibel, J.H., *See* Carpenter, J.A. Jr., 14:47373
Schneider, B.I., New developments in the ab initio treatment of low energy electron collisions with molecules, 14:48272 (R;US)
Schneider, L.X., Lifetime testing of commercially available 3.0 μf, 100 kV pulsed-power capacitors, 14:48690 (R;US)
See Vandevender, J.P., 14:48692
Schnetzler, C., *See* Garvin, J.B., 14:48197
Schnizer, W.A., Novel methods for treating the inverse scattering problem, 14:48568 (RA;AT;In German)
Schoeberl, W., *See* Blaser, P., 14:47071
Schoene, A.Y., *See* Sloane, T.M., 14:47685
Schoeneman, J.L., Land vehicle teleoperation under conditions of reduced video resolution, 14:47724 (R;US)
Schoepf, K., Impact transport of reaction products in magnetized fusion plasmas, 14:48592 (RA;AT;In German)
Schreiber, D.R., Selected equation of state in the acentric factor system, 14:47760 (J;US)
Schreiber, E., Thermal behaviour of transparent layers of insulation on building facades - comparison of measurement and calculation. Interim report, 14:47268 (R;DE;In German)

Schreier, K., *See* Handl-Zeller, L., 14:48108
Schuerrer, F., *See* Kuegerl, G., 14:48263
Schultz, A.J., *See* Williams, J.M., 14:47347
Schultz, F.J., *See* Caldwell, J.T., 14:46937
Schultz, K.L., *See* Shultz, S.M., 14:46890
Schultz, P.H., Non-random cratering flux in recent time, 14:48207 (RA;US)
Schwarz, J.H., Superconformal symmetry and superstring compactification, 14:48383 (J;US)
Schwarz, K., Status of high-temperature superconductors research in Austria, 14:47392 (RA;AT;In German)
Schwarzwald, R., Fluorescence studies of OH and CN radicals in atmospheric pressure flames using picosecond excitation, 14:47661 (BA;US)
Schweiger, E., *See* Abt, R., 14:47423
See Eisl, M., 14:47422
Schwinkendorf, K.N., *See* Tollefson, D.A., 14:47113
Scott, C.D., Biological solubilization of coal in aqueous and non-aqueous media, 14:46806 (RA;US)
Scott, M.C., *See* Rose, S., 14:48084
Scott, S.K., *See* Griffiths, J.F., 14:47679
Scotto, M.V., Quench-induced nucleation of ash constituents during combustion of pulverized coal in a laboratory furnace, 14:46866 (BA;US)
Seaba, J.P., *See* Chen, L.D., 14:47596
Sears, E.B., Central radon data base and digitized bedrock map of US EPA (Environmental Protection Agency) Region 1. Technical report, 14:47964 (R;US)
Seavey, K.P., Soviet concepts of ballistic missile defense. Master's thesis, 14:47319 (R;US)
Sebulke, J., Development and testing of a physical measurement system for exploring heated groundwater flows, e.g. for heat recovery with the aid of water/water heat pumps, 14:47286 (R;DE;In German)
Sechovsky, V., *See* Pillmayr, N., 14:47353
Seeker, W.R., *See* Slaughter, D.M., 14:46876
Seetula, J.A., *See* Russell, J.J., 14:47920
Seewald, J., *See* Thornton, E.C., 14:47066
Segev, G., Detonation waves through foam, 14:47692 (BA;US)
Seidenbusch, W., *See* Strasser, G., 14:47427
Seidensticker, R.W., *See* Wu, Ting-shu, 14:47131
Seidl, E., *See* Badurek, G., 14:48674
Seiler, D.G., Two-photon absorption characterization of HgCdTe. Interim report (Annual), August 1987-August 1988, 14:47410 (R;US)
See Littler, C.L., 14:47409
Selby, P.B., [Dose and dose-rate effects on radiation response]: Foreign trip report, May 5–13, 1989, 14:48135 (R;US)
[Participation in the Genetic Sub-subgroup at the United Nations Scientific Committee on the Effects of Atomic Radiation]: Foreign trip report, June 13–17, 1988, 14:48131 (R;US)
Selig, M., *See* Loesser, G. D., 14:48703
Semrad, D., Stopping cross section for fast ions, 14:48265 (RA;AT;In German)
See Goiser, R., 14:47828
Sen, R., *See* Fassbender, L.L., 14:47294
Senda, Ikuo, One-loop dynamics of four-dimensional string theory, 14:48370 (RA;JP)
Senjanovic, G., Grand unification: quo vadis domine?, 14:48404 (RA;PL)
Senkan, S.M., *See* Chang, W.D., 14:47664
See Russell, J.J., 14:47920
Serbo, V.G., *See* Ginzburg, I.F., 14:48352
Sergienko, V.I., *See* Kavun, V.Ya., 14:47549
Serio, M.A., *See* Solomon, P.R., 14:46820
Seshadri, K., *See* Smooke, M.D., 14:47674
Sevast'yanov, V.G., *See* Krasnodubskaya, S.V., 14:47552
Sevast'yanova, A.F., *See* Kup, V.S., 14:47518
Severino, G., *See* Marmolino, C., 14:48174
Severov, D.A., *See* Israel, Y.A., 14:47126
Seyfried, W.E. Jr., *See* Thornton, E.C., 14:47066
Sezgin, E., *See* Bergshoeff, E., 14:48392
Sfihi, H., *See* Legrand, A.P., 14:46837
Shaffer, J., *See* Doggett, G., 14:47715
Shah, J., *See* Atallah, S., 14:46911
Shah, S., *See* Pattipati, K.R., 14:48719
Shamaridn, V.K., *See* Pecherin, A.M., 14:47364
Shang Yuan Ren, Wavefunctions and charge densities for defects in solids: A success for semiempirical theory, 14:47341 (RA;US)
Shannon, D., Integrated environmental management: A need for change. Technical report, 14:47227 (R;US)
Shapira, D., [Cluster structure in nuclear and subnuclear matter, Kyoto, Japan, July 25–29, 1988]: Foreign trip report, 14:48479 (R;US)
Shapiro, S.M., *See* Torikachvili, M.S., 14:47330
Shapiro, W., Advanced helium purge seals for Liquid Oxygen (LOX) turbopumps. Final report, September 1985-August 1987, 14:47720 (R;US)
Sharma, R.P., *See* Rehn, L.E., 14:48497
Sharp, L.E., Review of techniques for fluctuation measurements, 14:48617 (RA;AU)
See Howard, J., 14:48611
See Tou, T.Y., 14:48682
Sharpton, V.L., *See* Desilva, S.L., 14:48194
See Koeberl, C., 14:48199
Shaughnessy, R.J., *See* Ferullo, A.F., 14:48033
Shaver, D.K., *See* Zirps, N.A., 14:47215
Shaw, D.W., *See* Essenhigh, R.H., 14:46885
Shaw, M.S., *See* Morris, C.E., 14:47433
Shcherbak, V.I., *See* Bykov, V.N., 14:47393
Sheaff, M., *See* Errede, D., 14:47825
Sheffield, S.A., Shock-induced reaction in several liquids, 14:48519 (R;US)
See Forest, C.A., 14:47858
Sheldon, D.E., *See* Van Deusen, L.C., 14:47003
Shelekhov, A.L., *See* Golovashkin, A.I., 14:47394
Shelnutt, J.A., *See* Crawford, B.A., 14:47022
Shelton, R.N., *See* Folkerts, T.J., 14:47405
See Peng, J.L., 14:48535
Shelton, W.W., Investigation of radiofrequency/microwave effects upon the central nervous system. Final report, 14:48157 (R;US)
Shen, S.S., Testing results of the MIT Probe, 14:48694 (R;US)
Shen, T.R., *See* Chan, S.H., 14:47601
Shen-Yann Chiu, *See* Martino, L.E., 14:47214
Shendrik, A.V., Radiation-induced paramagnetic centers in quartz blanks of optical waveguides, 14:48509 (RA;SU;In Russian)
Shepard, R.L., *See* Dunning, T.H. Jr., 14:47262
Shepherd, I.G., *See* Cheng, R.K., 14:47607
See Cho, P., 14:47603
Sheppard, D., Roles of pH, titratable acid, and specific chemical composition in mediating effects of acid aerosols on the airways. Final report, 14:48147 (R;US)
Sherman, R.H., *See* Anderson, J.L., 14:47166
See Yamanishi, T., 14:48700
Sherwin, J., *See* Zwicky, H.U., 14:47478
Shi, X.H., Drift wave study in SHEILA heliac, 14:48626 (RA;AU)
Shibata, Tokushi., *See* Sato, Shingo, 14:48490
Shibazaki, N., *See* Deeter, J.E., 14:48187
Shilyaev, B.A., *See* Mushnikov, V.N., 14:48513
Shima, K., *See* Imada, K., 14:48093
Shimamoto, Susumu, *See* Yamamura, Hidemasa, 14:48687
Shimizu, H., Asymmetry measurements in PP elastic scattering during polarized beam acceleration up to 4.4 GeV/c, 14:48295 (R;US)
Shin, Y.W., A method for suppression of pressure pulses in fluid-filled piping: Theoretical analysis, 14:47099 (R;US)
Shinn, N.D., *See* Arko, A.J., 14:48531
Shinya, Kichiro, Study on poloidal field coil optimization and equilibrium control of ITER, 14:48686 (R;JP)
Shirokov, M.I., Absorption jump mechanism of EPR in WO_3, MoO_3 compounds of heteropolyanion type, 14:48508 (RA;SU;In Russian)
Shklyaev, A.A., *See* Maksimov, N.G., 14:48507
Shodiev, U.M., Synthesis and investigation of vanadyl (2) coordination compounds with aromatic amino acids, 14:47489 (RA;SU;In Russian)
Shoemaker, C.S., *See* Shoemaker, E.M., 14:48208
Shoemaker, E.M., Asteroid and comet flux in the neighborhood of the earth, 14:48208 (RA;US)

Shoemaker, J.L., *See* Bostick, W.D., 14:46968
Shore, J.V., *See* Hackworth, J.H., 14:47284
Shpigunova, O.K., *See* Maksimov, N.G., 14:47516
Shtykov, S.N., *See* Chernova, R.K., 14:47506
Shtyrlin, V.G., *See* Veselov, I.A., 14:47497
Shultz, S.M., Drilling aspects of the deepest well in California, 14:46890 (BA;US)
Siberell, J.K., Technological issues in Y-12 plant RCRA land unit closures, 14:47982 (RA;US)
Sibtain, S.F., *See* Gibbs, B.M., 14:46875
Sichel, M., *See* Fan, B.C., 14:47691
See Pu, Yi Kang, 14:47694
Sichinava, A.B., *See* Diasamidze, Eh.M., 14:47367
Sickles, J.E., *See* Hering, S.V., 14:47937
Siddiqui, A.A., *See* Qadir, A., 14:48563
Sidorov, A.A., ESR study of platinum metal complexing in alkaline medium, 14:47499 (RA;SU;In Russian)
Siebert, R., *See* Frascaria, R., 14:48348
Siegfriedsen, S., *See* Matthies, H., 14:47069
Siegrist, J., *See* Stefanski, R., 14:47784
Sigmon, T.W, *See* Appleton, B.R., 14:47449
Siitonen, V., *See* Luoma, M., 14:47277
Silady, F.A., Safety aspects of the Modular High-Temperature Gas-Cooled Reactor (MHTGR), 14:47114 (R;US)
Siltanen, T., Energy consumption of single-family houses. Partly storing electrical heating, 14:47276 (R;FI;In Finnish)
Silveer, J., Improved DNA amplification technique, 14:48098 (P;US)
Silver, E., High resolution x-ray spectroscopy using germanium microcalorimeters, 14:47850 (R;US)
Silver, G.L., Operational measures of central tendency, 14:48729 (R;US)
Silvestro, J., *See* Narayan, R., 14:47712
Simak, V., Note on the constituent quark cross sections and average charged multiplicities, 14:48339 (RA;PL)
Polarisation effect of the rho-meson in interactions at 5.7, 12, 22.5 GeV/c, 14:48308 (RA;PL)
Siman, M., *See* Segev, G., 14:47692
Simell, P., *See* Staahlberg, P., 14:47020
Simmons, R.F., *See* Evans, S., 14:47662
Simon, G.G., Non-destructive measurements of water reactor fuel and evaluation of measurement techniques for improved assay accuracy, 14:47092 (RA;XA)
Simpson, B.R.S., Standardization of ^{67}Ga by liquid scintillation coincidence counting, 14:48492 (R;ZA)
Simpson, R.L., *See* Aldis, D.F., 14:47865
Simpson, W.F. Jr., Program distribution for unclassified scientific and technical reports: Instructions and category scope notes: Revision 75, 14:48741 (R;US)
Sinclair, G., *See* Jeffery, J.J., 14:46984
Singer, H.J., Multipoint measurements from substorm onset to recovery: The relation between magnetic pulsations and plasma-sheet thickening, 14:48236 (R;US)
Singer, S., Starting characteristics of direct current motors powered by solar cells, 14:47043 (R;US)
Singh, M.M., *See* Laurito, A.W., 14:46844
Sinitsyn, N.M., *See* Miroshnichenko, I.V., 14:47492
Sinor, J.E., Market assessment for hydrogen from the catalyzed gasification of low-rank coals, 14:47076 (BA;US)
Sirignano, W.A., *See* Cetegen, B.M., 14:47577
See Continillo, G., 14:47705
See Rangel, R.H., 14:47704
Sitte, W., *See* Gruber, H., 14:47426
Sjoreen, A., *See* Strand, R., 14:48746, 14:48747
Sjoreen, A.L., U.S. NRC emergency response dose assessment model, 14:47156 (BA;US)
Skachkov, G.K., *See* Borisov, A.A., 14:47620
Skeel, R.D., Potential for parallelism in explicit linear methods, 14:48724 (R;US)
Skelton, R., *See* Welch, K.M., 14:47801, 14:47804
Skidmore, D., *See* Harsh, D., 14:46807
Skocypec, R.D., *See* Erickson, K.L., 14:47860
Skubnik, M., Contract R&D technically administered by the Energy Research Laboratories. FY 1985/86, 14:47239 (R;CA)
Slagle, I.R., Kinetics of the reactions of unsaturated free radicals (methylvinyl and i-C_4H_3) with molecular oxygen, 14:47625 (BA;US)
Slattery, W.L., *See* DeWitt, H.E., 14:48228
Slaughter, D.M., Increased SO_2 removal with the addition of alkali metals and chromium to calcium-based sorbents, 14:46876 (BA;US)
Slavetskaya, A.I., Use of IR spectroscopy for determination of the structure of mixed-ligand lanthanide complexes with organic phosphorus compounds, 14:47505 (RA;SU;In Russian)
Sleptsov, A.N., *See* Arbuzov, V.L., 14:47361
Sloane, T.M., Energy requirements for spherical ignitions in atmospheric-pressure methane-air mixtures: A computational study, 14:47685 (BA;US)
Smart, J.C., *See* Canales, T.W., 14:47771
Smart, J.P., Reduction of NO_x emissions in a swirled coal flame by particle injection into the internal recirculation zone, 14:46872 (BA;US)
Smirnov, V.P., *See* Ljadov, G.D., 14:47090
Smirnova, T.D., *See* Chernova, R.K., 14:47506
Smith, A.M., Ion bombardment in radio-frequency glow discharges, 14:48504 (RA;AU)
Smith, B., *See* Schenkel, R., 14:47007
Smith, C.W., Junior Jade events - An investigation of decoupling phenomenology, 14:47873 (RA;US)
Stemming column phenomenology, 14:47884 (RA;US)
See Dykhuizen, R.C., 14:47899
See Swan, C.C. Jr., 14:47881
Smith, D.A., Study of muons associated with jets in proton-antiproton collisions at $\sqrt{s}$ = 1.8 TeV, 14:48297 (R;US)
Smith, D.K ., *See* Taylor, J.S., 14:48038
Smith, D.M., Use of quantitative risk assessment and risk management in a facility siting issue at Randolph Air Force Base, 14:47984 (RA;US)
Smith, G.P., *See* Kohse-Hoeinghaus, K., 14:47465
Smith, J.E., NASA Marshall Space Flight Center solar observatory report, January-December 1987, 14:48217 (R;US)
Smith, J.R., A supplementary adaptive var unit controller for power system damping, 14:47077 (J;US)
Metals in intimate contact, 14:47336 (RA;US)
Smith, L.S., *See* Nichols, D.K., 14:47437
Smith, O.I., *See* Hepler, W.A., 14:47696
Smith, P., *See* Keller, C., 14:47882
Smith, R.H., Maximum-likelihood identification of structurally constrained covariances for initial-condition statistics, 14:48538 (R;US)
Smith, S.G., *See* Neulicht, R.M., 14:47948, 14:47949
Smith, V.K., *See* Desvousges, W.H., 14:47965
Smith, W.C., *See* Kakwani, R.M., 14:46884
Smooke, M.D., The structure an extinction of partially premixed flames burning methane in air, 14:47674 (BA;US)
Smuda, P.A., *See* Clay, J.P., 14:47914
Sn, *See* Bonvin, E., 14:48292
Snover, K.A., Giant nuclear resonances, 14:48465 (R;US)
Snurnikova, A.I., *See* Igrushin, V.V., 14:47363
Sobel, H., *See* Baumann, N., 14:48304
Sobiesiak, A., *See* Weckman, E.J., 14:47651
Soda, Jiro, Renormalization group flow and string dynamics, 14:48365 (RA;JP)
Soda, Kunihisa, *See* Maruyama, Yu, 14:48744
Sokolowski, D.E., Toward improved durability in advanced aircraft engine hot sections, 14:47774 (R;US)
Sokolowski, L.M., Are gravitons windows to higher dimensions, 14:48552 (R;XA)
Solomon, P.R., A study of depolymerization and crosslinking reactions in coal liquefaction: Final report, 14:46820 (R;US)
Application of FT-IR emission/transmission (E/T) spectroscopy to study coal combustion phenomena, 14:46863 (BA;US)
Song, X.M., *See* Cool, T.A., 14:47462
Sonich-Mullin, C., Drinking-Water Criteria Document for Asbestos (final draft), March 1985, 14:48064 (R;US)
Sonnenschein, J., Moduli spaces and topological quantum field theories, 14:48418 (R;US)

Sorbo, N.W., An experimental investigation of the incineration and incinerability of chlorinated alkane droplets, 14:47709 (BA;US)
Sorensen, S.P., *See* Awes, T.C., 14:48485
Sormann, H., Electron-positron annihilation rates in metals, 14:47354 (RA;AT;In German)
Sorokin, N.N., *See* Chernova, R.K., 14:47506
Soroko, V.E., *See* Minyaev, A.I., 14:47524
Soukas, A.V., *See* Zhang, W., 14:47802
Sozer, A., Component and system simulation models for High Flux Isotope Reactor, 14:47119 (R;US)
Spalding, B.P., Field demonstration of in situ vitrification for application to ORNL liquid waste disposal trenches, 14:46952 (RA;US)
Spalinski, M., *See* Olechowski, M., 14:48328
Spann, J.F., *See* Maloney, D.J., 14:46877
Spanne, P., *See* Gordon, B.M., 14:47461
Sparkman, J.P., A computer program for the IBM-PC/Sheffield air column interface, 14:48730 (R;US)
Spear, R.H., Measurement of reduced electric octupole transition probabilities $B(E3;O_1^+ \rightarrow 3_1^-)$, for $^{118,120,122}Sn$, 14:48449 (R;AU)
Reduced electric-octupole transition probabilities, $B(E3;O_1^+ \rightarrow 3_1^-)$, for even-even nuclides throughout the periodic table, 14:48427 (R;AU)
See Burnett, S.M., 14:48451
See Lim, C.S., 14:48455
See Vermeer, W.J., 14:48439, 14:48450
Spillett, C.T., Flash photolysis studies of RhCl(CO)L2 (L = trimethyl- or tritolylphosphine). Evidence for intermediates in the photocatalytic carbonylation of hydrocarbons, 14:47541 (J;US)
Spycher, N.F., Boiling of geothermal waters: precipitation of base and precious metals, speciation of arsenic and antimony, and the role of gas phase metal transport, 14:47060 (RA;US)
Squires, R.G., *See* Waters, B.J., 14:47557
Srinivasan, V., A review on the effects of microalloying, surface treatment and oxidation conditions on the formation and breakdown of protective oxide scales on fossil energy materials, 14:46824 (R;US)
Srolovitz, D.J., *See* Anderson, M.P., 14:48537
St. Clair, G.T., Impacts from the implementation of a prioritization system for funding inactive waste site remediation activities at the Savannah River Plant, 14:46953 (RA;US)
Staahlberg, P., Updraft gasification of waste fuels, 14:47020 (R;FI;In Finnish)
Stadlbauer, A., *See* Goiser, R., 14:47828
Stahl, D.B., *See* Paisley, D.L., 14:47846
Stainbrook, N.E., Vacuum heat training furnace: Final technical report, 14:47717 (R;US)
Staines, G., *See* Besson, G., 14:48607
Stamps, D.W., Uncertainties in hydrogen combustion for nuclear reactor safety, 14:47151 (R;US)
Stancell, D.F., DOT/OSHA/EPA (Department of Transportation/Occupational Safety and Health Administration/Environmental Protection Agency) integrated DOE (Department of Energy) transportation training, 14:47219 (RA;US)
Stanley, J.S., Evaluation of high-resolution gas for the determination of 2, 3, 7, 8-TCDD in soil, sediment and water (journal version), 14:47479 (R;US)
Stapp, H.P., *See* Bedford, D., 14:48420
Stark, M., *See* Haines, T.J., 14:48183
Starr, T.L., Low temperature processing of reaction sintered silicon nitride, 14:47401 (R;US)
Starrh, L., *See* Hudson, B., 14:47900
Steeper, R.R., *See* Sorbo, N.W., 14:47709
Stefanski, R., Report of the Ad Hoc Committee on Test Beam Policy, 14:47784 (R;US)
Steiman-Cameron, D.V., *See* Steiman-Cameron, T.Y., 14:48231
Steiman-Cameron, T.Y., High-speed optical photometry of the DQ Herculis object H2215-086, 14:48231 (J;US)
Stein, H.J., Hydrogen-assisted thermal donor formation in silicon, 14:48522 (R;US)
Stein, S.E., *See* Fahr, A., 14:47630
Stein, W.E., Stability requirements of rf linac-driven free-electron lasers, 14:47744 (R;US)
Steinberg, D.J., A rate-dependent constitutive model for Be, 14:48525 (R;US)
Steinberg, M., Mild gasification mechanisms and char conversion, 14:46792 (R;US)
Steinhauser, M., *See* Hoffmann, G., 14:47548
Stelbovics, A.T., *See* Mitroy, J., 14:48247
Stell, G., *See* Zhou, Y., 14:47759
Stepowski, D., Laser Mie scattering measurement of mean mixture fraction density and temperature by conditional seeding in a turbulent diffusion flame, 14:47591 (BA;US)
Stetler, K.A., *See* Kyrala, G.A., 14:47719
Steuber, T.J., *See* Banks, B.A., 14:47439
Steuer, M.F., Intermediate-velocity molecular and atomic ions in solids, 14:48528 (J;NL)
Stevens, D., *See* Wright, L.L., 14:47030
Steward, P.H., Tabulation of rate constants for combustion modeling, 14:47624 (BA;US)
Stewart, C.D., *See* Moss, J.B., 14:47573
Stewart, D.L., *See* Pyne, J.W., 14:46804
Stewart, R.C., Remote-handled transuranic solid waste characterization study: Oak Ridge National Laboratory, 14:46975 (R;US)
Stewart, T.B., *See* Lince, J.R., 14:48495
Stiefel, S., *See* Reimann, M., 14:47144
Stine, J.R., *See* Storm, C.B., 14:47859
Stipp, S.L., Evaluation of an equilibrium speciation model for the acid aqueous iron sulfate system at 25°C, 14:46838 (RA;US)
Stirpe, D., Mathematical determination of α and β for the rotating-slit enrichment monitor, 14:46928 (R;US)
Stock, L.V., *See* Han, K.S., 14:47746
Stoetzel, G.A., *See* Jamison, J.D., 14:47160
See Moeller, M.P., 14:47155
Stogov, Yu.V., *See* Polyakov, A.A., 14:47093
Stohl, K., *See* Goiser, R., 14:47828
Stollberger, R., NMR imaging of the high-frequency field, 14:48107 (RA;AT;In German)
Stoner, D.L., Microbial degradation of organosulfur compounds: Implications for the microbial desulfurization of coal, 14:46809 (RA;US)
Storer, R.G., Resistive magnetohydrodynamic spectra, 14:48631 (RA;AU)
See Brotherton-Ratcliffe, D., 14:48613
Storm, C.B., Sensitivity relationships in energetic materials, 14:47859 (R;US)
Stout, R.B., Multi-component stress history measurements and analysis, 14:47880 (RA;US)
Stovall, J.P., *See* Adibi, M.M., 14:47716
Stow, S.H., [Preparation of a document on the subsurface disposal of liquid hazardous waste]: Foreign trip report, April 22–29, 1989, 14:46972 (R;US)
Strachan, J.D., Image simulation using LOCUS, 14:48660 (R;US)
Strack, B., *See* Struble, G.L., 14:47245
Strahle, W.C., Fractal geometry applications in turbulent combustion data analysis, 14:47585 (BA;US)
Strain, R.V., *See* Neimark, L.A., 14:47165
Straka, T.J., *See* Wright, L.L., 14:47030
Strand, R., The external design phase of the breeding and multigeneration support system: A tracking and decision support system for NCTR [National Center for Toxicological Research], 14:48746 (R;US)
The internal design phase of the breeding and multigeneration support system: A tracking and decision support system for NCTR [National Center for Toxicological Research], 14:48747 (R;US)
Strandburg, K.J., Computer simulations of two-dimensional quasiperiodic crystal and random tiling models, 14:47418 (R;US)
Strasser, G., Far infrared spectroscopy on high temperature superconductors. $YBa_2Cu_{3-x}Zn_xO_{7-y}$, 14:47427 (RA;AT;In German)
Strenge, D.L., *See* Higley, K.A., 14:47220
Strenger, M.R., Formation of NO_x and burnoff of CO during thermal quenching of the products from combustion in a thermally stabilized burner, 14:47642 (BA;US)
Strikman, M., *See* Mtingwa, S.K., 14:48324
Stringfellow, G.S., *See* DeWitt, H.E., 14:48228
Strip, D., Rethinking synthesis of fine-motion strategies, 14:47723 (R;US)

Strom, D., Recent results on weak decays from DESY, 14:48309 (RA;PL)
Strottman, D.D., An overview of relativistic hydrodynamics as applied to heavy ion reactions, 14:48473 (R;US)
Struble, G.L., Nuclear Test-Experimental Science: Annual report, fiscal year 1988, 14:47245 (R;US)
See Namboodiri, M.N., 14:48460
Strum, M.J., *See* Summers, L.T., 14:47726
Stuart, W.B., Research and development in wood energy harvesting and handling, 14:47034 (RA;CA)
Stubbs, C.W., Eoet-Wash constraints on multiple Yukawa interactions and on a coupling to "isospin", 14:48437 (R;US)
Stubbs, T., *See* Hudson, B., 14:47900
Stubington, J.F., A combined oxygen/bubble probe for the study of fluidized bed combustion of volatiles, 14:46871 (BA;US)
Stuchbery, A.E., Spectroscopy of ^{212}Rn, 14:48454 (R;AU)
See Dracoulis, G.D., 14:48453, 14:48456
Stucky, G.D., *See* Eddy, M.M., 14:47529
Studer, A., Spectroscopic measurement of ion and atom temperatures in a metal vapour vacuum arc, 14:48269 (RA;AU)
Stuecklschweiger, G., Dosimeter readings reproducibility in water phantom measurements at electron accelerators with a beam scanning system, 14:47809 (RA;AT;In German)
See Leitner, H., 14:48110
See Poier, E., 14:48125
Styers, D.R., Assessment of potential worker exposure during the operational phase of the Tumulus disposal demonstration project, 14:46950 (RA;US)
Su Zhaobin, *See* Chen Hao, 14:48530
Sudan, R.N., *See* Hammer, D.A., 14:48671
Suematsu, Daijiro, Superpotential in Calabi-Yau compactification, 14:48380 (RA;JP)
Sugama, T., Polyelectrolyte-diffused zinc phosphate conversion coatings and polyacid coupling primers for corrosion protection of steel and aluminum, and alkali-catalyzed hydrolysis of polyimide-based materials: Final report, 14:47414 (R;US)
Sugihara, Masayoshi, *See* Shinya, Kichiro, 14:48686
Sugihara, Ryo., Unlimited acceleration of particles by a system of multi-laser beams, 14:48684 (R;JP)
Sujsalu, A., ODMR study of excited trip-multiplet states of Gd(3) complexes, 14:47500 (RA;SU;In Russian)
Sula, M.J., *See* Lyon, M., 14:47837
Sullivan, J.C., *See* Appelman, E.H., 14:47556
Summers, L.T., The characterization of Nb_3Sn superconductors for use in magnets of 19 T and greater, 14:47726 (R;US)
The International Thermonuclear Experimental Reactor (ITER): Design and materials selection, 14:48695 (R;US)
Sundaram, M.S., *See* Steinberg, M., 14:46792
Sundaresan, M.K., Magnetic monopoles in Kaluza-Klein theory, 14:48403 (RA;PL)
Surgeoner, D.M., *See* Lodde, G.M., 14:47183
Surget, J., *See* Poinsot, T., 14:47657
Sursock, J.P., EPRI workshop on fire protection in nuclear power plants: Final report, 14:47138 (R;US)
Sutherland, J.W., *See* Patterson, P.M., 14:47482
Sutton, S.R., *See* Gordon, B.M., 14:47461
Suuberg, E.M., Reaction order for low temperature oxidation of carbons, 14:47559 (BA;US)
Suvorov, A.L., *See* Babaev, V.P., 14:48512
Suzuki, Hiroshi, BRS formulation of bosonic string theory and the properties of non-critical strings, 14:48374 (RA;JP)
Suzuki, Koji, *See* Sadakata, Masayoshi, 14:46860
Suzuki, Shinobu, *See* Ikeshima, Yoshiaki, 14:47118
Svetashev, A.G., Laser spectroscopy of rare earth (3) ion complexes with inorganic anions in nonaqueous solutions, 14:47507 (RA;SU;In Russian)
Svetlov, V.D., *See* Boguslavskij, A.A., 14:47501
Swan, C.C. Jr., Theoretical and experimental analyses of in-situ gauge inclusion effects, 14:47881 (RA;US)
Sweeney, M.A., *See* Mendel, C.W. Jr., 14:48691
Swift, P., Cathode spot phenomena in continuous and pulsed vacuum arcs, 14:48270 (RA;AU)
Swift, R.P., *See* Rambo, J.T., 14:47895
Swihart, J.C., *See* Allen, P.B., 14:48536
Swindle, D.W. Jr., A methodology for identifying, evaluating, and controlling the incremental risk of inadvertent sensitive information disclosure during on-site verification inspections at US facilities, 14:47322 (R;US)
Swinney, H.L., Complex temporal and spatial patterns in nonequilibrium systems: Progress report, December 1, 1988–November 30, 1989, 14:48498 (R;US)
Swithenbank, J.R., *See* Bradley, D., 14:47693
Syed, K.J., *See* Moss, J.B., 14:47573
Sykes, G.F. Jr., *See* Funk, J.G., 14:47434
Sykes, R.I., *See* Lewellen, W.S., 14:47957
Syred, N., *See* Morgan, D., 14:46859
Szego, K., P/Halley the model comet, in view of the imaging experiment aboard the VEGA spacecraft, 14:48182 (R;HU)
Szwed, R., Novel approach to scaling in multiplicity, 14:48338 (RA;PL)

T

Tabor, M.A., In-vessel remote maintenance of the Compact Ignition Tokamak, 14:48704 (J;US)
Tachibana, Hiroyuki, *See* Nakamura, Yoshiteru, 14:47015
Tada, Eisuke, *See* Yamamura, Hidemasa, 14:48687
Tag Eldin, I.M.A., Study of the optical potential for hadron-nucleus scattering using Glauber's theory, 14:48467 (R;XA)
Tague, J.L., *See* Kuchnir, M., 14:47352
Tai, Chang Sheng, *See* Pu, Yi Kang, 14:47694
Takada, Isao, *See* Nakamura, Yoshiteru, 14:47015
Takagi, A., *See* Shimizu, H., 14:48295
Takagi, S., *See* Ohtani, S., 14:48516
Takahara, Shin-ichi, Experiment on removal of radon in water by using of de-airing membrane, 14:48048 (RA;JP;In Japanese)
Takahashi, F., *See* Li, S.C., 14:47706
Takahashi, Hiroshi, Muon catalyzed fusion in plasma state and high intensity DT fusion neutron source, 14:48667 (R;US)
Takala, B.E., *See* Crane, S.L., 14:47855
Takama, Michiaki, On bosonization in BC system, 14:48372 (RA;JP;In Japanese)
Takao, Masaru, Introduction to W-algebras, 14:48410 (RA;JP)
Takebe, Shinichi, Migration of multiradionuclides in sandy soil layer at different acidityes, 14:47993 (R;JP;In Japanese)
Takeda, Hisahiro, Model experiments of ship fire, 14:47652 (BA;US)
Takeda, Tatsuoki, *See* Yamaguchi, Yuji, 14:48652
Takemori, H.T., *See* Cutting, J.L., 14:47768
Takeno, Keiji, Behavior of combustible liquid soaked in porous beds during flame spread, 14:46922 (BA;US)
Takeno, Tadao, *See* Murayama, Motohide, 14:47584
Talbot, L., *See* Cheng, R.K., 14:47607
Taliman, C.R., *See* Kyrala, G.A., 14:48273
Talmage, S.S., *See* Walton, B.T., 14:48143
Talukdar, B., Half-shell scattering on Coulomb-distorted Graz potentials, 14:48469 (R;XA)
Talukdar, I., *See* El-Ashry, M.Y., 14:48587
Tam, Hon-Wah, *See* Skeel, R.D., 14:48724
Tamai, Hiroshi, Experimental observation of ion Bernstein wave heating on JFT-2M tokamak, 14:48653 (R;JP)
Tamai, R., *See* Barbella, R., 14:47707
Tambe, M., *See* Gupta, A., 14:48714, 14:48715
Tanahashi, S., User's manual of self learning gas puffing system for plasma density control, 14:48726 (R;JP;In Japanese)
Tanaka, Isao, *See* Ikeshima, Yoshiaki, 14:47118
Tanaka, K., *See* Sundaresan, M.K., 14:48403
Tang, R.T., Materials Aerometric data base for use in developing materials damage functions, 14:47967 (R;US)
Tang, S.Y., *See* Neynaber, R.H., 14:48243
See Thomson, J.S., 14:46836
Taniguchi, Y., Development of the monitoring system for the JIPPT-IIU operation, 14:48685 (R;JP;In Japanese)
Tanii, Y., *See* Bergshoeff, E., 14:48392
Tanii, Yoshiaki., *See* Saitoh, Yoshihiro, 14:48373
Tao, C., Recent results from UAI, 14:48299 (RA;PL)
Taormina, A., *See* Eguchi, Tohru, 14:48363
Tarasikov, V.P., *See* Bykov, V.N., 14:47393
Tarasov, O.Yu., *See* D'yachkova, T.A., 14:47521

Tarrer, A.R., *See* Curtis, C.W., 14:46898
Tarver, C., *See* Erskine, D.J., 14:47863
Tarver, C.M., *See* Urtiew, P.A., 14:47864
Tasso, H., Lyapunov stability of large systems of van der Pol-like oscillators and connection with statistics and turbulence, 14:48515 (R;DE)
Tawara, H., *See* Ohtani, S., 14:48516
Taylor, A.C., Study and assessment of eight yard waste-composting programs across the United States. Technical report, 14:47299 (R;US)
Taylor, A.J., *See* Kyrala, G.A., 14:48273
Taylor, J.S., Cost and performance of membranes for organic control in small systems: Flagler Beach and Punta Gorda, Florida. Final report, 1 June 1986-28 February 1989, 14:48038 (R;US)
Taylor, P.A., *See* Dodson, W., 14:47455
Taylor, P.H., Flame propagation along a vented duct containing grids, 14:47656 (BA;US)
Taylor, R.D., *See* Pasternak, M.P., 14:48518
Taylor, R.T., *See* Hanna, M.L., 14:48095
Taylor, S.R., *See* Patton, H.J., 14:47915
Taylor, S.W., *See* Jaffe, P.R., 14:48030
Teegarden, B.J., *See* Schaefer, B.E., 14:48230
Teichert, W.P., Application of minimization techniques to metal preparation and finishing operations in the Air Training Command, 14:47216 (RA;US)
Telegdi, V.L., General QED/QCD aspects of simple systems, 14:48419 (R;US)
Temps, F., *See* Bley, U., 14:47537
Tendys, J., RF generated plasmas for plasma immersion ion implantation, 14:48624 (RA;AU)
See Collins, G.A., 14:48595
Teodorczyk, A., Propagation mechanism of quasi-detonations, 14:47689 (BA;US)
Ternopol', A.M., *See* Volkov, E.D., 14:47368
Teske, R.G., Forbidden coronal iron line emission in the Puppis A shock front: The effect of inhomogeneities, 14:48188 (R;US)
Tester, J.W., Hot Dry Rock geothermal energy— A new energy agenda for the twenty-first century, 14:47056 (R;US)
Tewarson, A., Flame propagation for polymers in cylindrical configuration and vertical orientation, 14:47645 (BA;US)
Thayer, K.J., Physics Division annual review, April 1, 1988–March 31, 1989, 14:48426 (R;US)
Theilhaber, K., Auxiliary-field transformations for repulsive potentials: A physical approach, 14:48577 (R;US)
Thibault, P.A., *See* Mackay, D.J., 14:47655
Thielen, K., *See* Burmeister, M., 14:47636
Thole, K.A., *See* Clay, J.P., 14:47914
Thomas, B.L., *See* Pyne, J.W., 14:46804
Thomas, H., Room clearance and radiation safety interlock system for neutron therapy treatment room, 14:48111 (R;ZA)
Thomas, M.G., *See* Post, H.N., 14:47040
Thomas, V., Hybrid simulations of a curved shock, 14:48184 (R;US)
Thomas, V.A., *See* Jones, M.E., 14:48655
Thomi, H.A., *See* Zwicky, H.U., 14:47478
Thomlinson, W., *See* Thompson, A.C., 14:47459
Thompson, A.C., Imaging of coronary arteries using synchrotron radiation, 14:47459 (J;NL)
Thompson, J.D., *See* Arko, A.J., 14:48531
Thompson, J.R., *See* Lackey, W.J., 14:47408
Thompson, P.H., *See* Hawkins, W.L., 14:47909
Thompson, S.L., *See* Tripoli, G.J., 14:48209
Thoms, K.R,, [Reactor irradiation techniques]: Foreign trip report, November 7–11, 1988, 14:48689 (R;US)
Thomson, J.S., The effect of degree of aromaticity and alkyl substitution of polyaromatic hydrocarbons on instrumental response factors, 14:46836 (R;US)
Thorne, L.R., *See* Tully, F.P., 14:47638
Thornton, E.C., Chlorite solubility between 200°C and 350°C: An experimental and theoretical modeling study, 14:47066 (RA;US)
Thornton, M.M., *See* Westbrook, C.K., 14:47616
Thring, R.H., *See* Martin, N.L., 14:46912
Tian Decheng, Fractal dimension of a quasi-two-dimensional Sierpinski gasket as a conductor, 14:48501 (R;XA)
Tien, J.S., *See* Olson, S.L., 14:47644
Tigges, C.P., Energy relaxation of light holes in $InAs_{.15}Sb_{.85}$/InSb multiple quantum wells, 14:48523 (R;US)
Tikhonon, F.F., *See* Borisov, G.V., 14:48349
Timoshchenko, N.I., *See* Volkov, S.V., 14:47510
Tincknell, M.L., *See* Young, G.R., 14:48444
Tinus, R.W., Effects of global atmospheric perturbations on forest ecosystems: Predictions of seasonal and cumulative effects, 14:47926 (RA;US)
Tirsell, K.G., *See* Carter, M.R., 14:47838
Titulaer, U. M., *See* Hubmer, G.F., 14:48260
Titulaer, U.M., *See* Kainz, A., 14:48261
See Widder, M.E., 14:48262
Tognotti, L., Spontaneous combustion in beds of coal particles, 14:46862 (BA;US)
Toi, K., Limiter H-modes in the JIPP T-IIU tokamak, 14:48650 (R;JP)
Tollefson, D.A., Physics support analyses for full central-zone flux flattening for full-power (3000- to 4000-MW) operation, 14:47113 (R;US)
Tolstolutskaya, G.D., Study of radiation damages of Ni monocrystals implanted with Xe^+ ions, 14:47369 (RA;SU;In Russian)
Tomasello, P., *See* Frost, L., 14:48252
See Grisogono, A.M., 14:48254
Tomic, B., *See* Lederman, L., 14:47161
Tomilova, L.G., Absorption spectra of rare earth diphthalocyanines in the near IR region, 14:47504 (RA;SU;In Russian)
Tominaga, Hiroaki, *See* Sadakata, Masayoshi, 14:46860
Tomita, Kenji, Gravitational lens effect on the cosmic background radiation due to nonlinear inhomogeneities, 14:48223 (R;JP)
Tondeur, Y., *See* Stanley, J.S., 14:47479
Topping, R.F., Advanced-technology gas-fired commercial clothes dryer. Final report, April 1985-December 1988, 14:46907 (R;US)
Toran, L.E., *See* Dreier, R.B., 14:48027
Torchilin, V., *See* Holmberg, E., 14:48101
Torikachvili, M.S., Observation of long-range ferromagnetic order in the heavy-fermion compuound $URu_{1.2}Re_{0.8}Si_2$ by neutron scattering, 14:47330 (R;US)
Tou, T.Y., Electron-beam measurements of the magnetic surfaces in SHEILA, 14:48682 (RA;AU)
See Blackwell, B.D., 14:48614
Tourbot, R., *See* Boucher, B., 14:47334
Toyama, T., *See* Shimizu, H., 14:48295
Trachevskij, V.V., Molybdenum (5) different-ligand complexes with 1,1,'- and 1,2-dithiols, 14:47519 (RA;SU;In Russian)
See Pilipenko, A.T., 14:47494, 14:47523
Trapeznikov, A.V., *See* Koulikov, N.V., 14:48047
Traub, R.J., Financial impact of implementing draft ANSI Standard N13.30, performance criteria for radiobioassay, 14:47148 (R;US)
Treacy, E.B., Transverse pumping with diode lasers. Technical report, 14:47739 (R;US)
Tribble, R.E., *See* Gagliardi, C.A., 14:47824
Trickey, S.B., Structural stability calculations for films and crystals, 14:47345 (RA;US)
Tripoli, G.J., 3-dimensional numerical simulation of the atmospheric injection of aerosols by a hypothetical basaltic fissure eruption, 14:48209 (RA;US)
Troe, J., Toward a quantitative understanding of elementary combustion reactions, 14:47615 (BA;US)
Trokhimenko, O.M., *See* Pilipenko, A.T., 14:47523
Troshin, K.Ya., *See* Borisov, A.A., 14:47620
Trott, W.M., *See* Renlund, A.M., 14:47861
Trowbridge, D., *See* Caruso, J.J., 14:47436
Trudeau, D.A., *See* Hoover, D.L., 14:47907
Truelove, J.S., Coal combustion models for flame scaling, 14:46857 (BA;US)
Trujillo, V.L., Design and demonstration of a high-temperature, deployable, membrane heat-pipe radiator element, 14:47752 (R;US)
Truman, R.B., *See* Guidry, F.K., 14:46906
Trummer, D.J., *See* Bumpus, S.E., 14:47729
Tsai, S.C., Roles of additives and surface control in slurry atomization: Quarterly report, 14:46833 (R;US)
Tsang, I., Design features of earth mounded concrete bunkers for LLRW (low-level radioactive waste) disposal, 14:46944 (RA;US)

Tsang, W., Mechanism and rate constants for the reactions of hydrogen atoms with isobutene at high temperatures, 14:47629 (BA;US)
Tsao, NAI-KUAN, Eequivalence of Gaussian elimination and Gauss-Jordan reduction in solving linear equations, 14:48575 (R;US)
Tsepelev, A.B., *See* Bystrov, L.N., 14:47365
Tseytlin, A.A., Sigma models and renormalization of string loops, 14:48388 (R;XA)
Tskhakaya, D.D., *See* El-Ashry, M.Y., 14:48586
See Ogunniyi, J.F., 14:48588
Tsuchiya, Akihiko, Evaluation of one-loop mass shifts in open superstring theory, 14:48371 (RA;JP)
Tsuji, Hiroshi, *See* Yamaoka, Ichiro, 14:47675
Tsukamoto, T., *See* Kono, M., 14:47303
Tsutsumi, Masahiro, *See* Moriuchi, Shigeru, 14:47961
Tsutsumi, N., *See* Imada, K., 14:48093
Tsvirko, M.P., *See* Svetashev, A.G., 14:47507
Tsyganov, E.N., Organization of DELPHI experimental data analysis. DELPHI interactive graphics centre at JINR, 14:48745 (RA;SU)
Tujbaev, M.K., *See* Minin, V.V., 14:47490
Tulipano, F.J., *See* Block, O.U.J., 14:46954
Tully, F.P., Free-radical oxidation of isocyanic acid, 14:47638 (BA;US)
Tuozzolo, J.E., *See* Welch, K.M., 14:47801, 14:47804
Turekian, K.K., Causes for geographical variations in OS187/OS186 at the Cretaceous-Tertiary boundary, 14:48210 (RA;US)
Turnbull, D., *See* Aziz, M.J., 14:47458
Turner, D.W., *See* Caldwell, J.T., 14:46937
Turner, G.M., Spectroscopic measurements of the energy of sputtered copper atoms, 14:48502 (RA;AU)
Turner, M.B., *See* Neulicht, R.M., 14:47948, 14:47949
Turner, M.J., Preliminary assessment of offshore platform conversion to geothermal power station, 14:47052 (R;GB)
Turner, M.S., Positron line radiation from halo WIMP annihilations as a dark matter signature, 14:48216 (R;US)
Turner, R.R., *See* Yeh, G.T., 14:46971
Turok, N., *See* Albrecht, A., 14:48218
Turov, A.V., *See* Komarov, I.V., 14:47522
Tuthill, C.D., *See* Watkins, R.D., 14:47446

U

Ueno, A., *See* Shimizu, H., 14:48295
Uhrig, R.E., Use of probabilistic risk assessment (PRA) in expert systems to advise nuclear plant operators and managers, 14:47157 (BA;US)
Ujiie, Y., *See* Kono, M., 14:47303
Underhill, W., *See* Pavelek, M.D. II, 14:47191
Unterkofler, K., *See* Bulla, W., 14:48565
Urtiew, P.A., Shock initiation of LX-17 as a function of its initial temperature, 14:47864 (R;US)
Usachev, A.V., *See* Akhmin, S.M., 14:47486
Usuda, Shigekazu, Studies on rapid ion-exchange separation of the transplutonium elements with mineral acid-methanol mixed media, 14:47553 (R;JP)
Uwamino, Yoshitomo, *See* Sato, Shingo, 14:48490

V

Vadnal, J.L., Characterization of hazardous spill transport in the Clinch River, Tennessee, 14:48019 (RA;US)
Valle, J.W.F., Neutrinos beyond the Standard Model, 14:48357 (R;US)
Vallem, R.J., Surface activity characterization with TLD rings, 14:47174 (J;US)
Vampola, A.L., Space particle environment. Technical report, 14:48237 (R;US)
Van Cleve, J.E., *See* Van Hoesen, S.D., 14:46945
Van Deusen, L.C., Corrective action investigation of a mixed waste contaminated percolation pond, 14:47003 (R;US)
Van Hoesen, S.D., Design, construction, and operations experience with the SWSA 6 (Solid Waste Storage Area 6) tumulus disposal demonstration, 14:46945 (RA;US)
[US low-level radioactive waste management facility design, construction, and operation]: Foreign trip report, July 22–30, 1989, 14:46973 (R;US)
See Allen, D.F., 14:46936
See Hutchison, C.A., 14:46935
Van Riper, K.A., TIKTEK: A Tektronix emulator based on 2D GMR, 14:48728 (R;US)
van Steenbergen, A., Considerations in SR facility planning: Technical options in the design of an intermediate energy synchrotron radiation source, 14:47780 (R;US)
van Stijn, T.L., Supercomputers, architectures and applications, 14:48734 (R;NL;In Dutch)
Van Tiggelen, P.J., *See* Vandooren, J., 14:47678
Vancil, M.A., *See* Epner, E.P., 14:47955
Vancil, M.C., *See* Adams, R.C., 14:47950
VanderHart, P.G., Critique of several regulatory analyses regarding solvent wastes. Technical report, 14:48000 (R;US)
VanderMolen, H.J., *See* Moeller, M.P., 14:47155
Vandervoort, K., *See* Arko, A.J., 14:48531
Vandevender, J.P., Pulsed-power switching for inertial confinement fusion with light ion beams, 14:48692 (R;US)
Vandooren, J., The inhibiting effect of CF_3H on the structure of a stoichiometric $H_2/CO/O_2$/Ar flame, 14:47678 (BA;US)
Vandsburger, U., *See* Lewis, G.S., 14:47580
Vaniman, D.T., *See* Bolivar, S.L., 14:46970
Vantelon, J.P., *See* Bouhafid, A., 14:47650
Vasatis, I., New interpretation of rupture strength using the potential drop technique, 14:47383 (BA;US)
Vasil'ev, N.G., *See* Pilipenko, A.T., 14:47494
Vavra, J., *See* Simak, V., 14:48339
Veal, B.W., *See* Arko, A.J., 14:48531
Vecsernyes, P., *See* Balog, J., 14:48398
Vedam, K., *See* Ravindra, N.M., 14:47406
Vedha-Nayagam, M., *See* Altenkirch, R.A., 14:47668
Vejsig Pedersen, P., Attractive economy and durability of building integrated solar collector systems, 14:47049 (RA;DK)
Vender, D., Simulation of a RF parallel plate discharge, 14:48599 (RA;AU)
Venitozzi, C., *See* Borghese, A., 14:47304
Venturini, E.L., Effects of shock-modification on superconductivity in $Tl_2Ca_2Ba_2Cu_3O_y$ and $Bi_2CaSr_2Cu_2O_x$, 14:47404 (R;US)
Ver Berkmoes, A.A., *See* Pontau, A.E., 14:47480
Vermaseren, J.A.M., *See* Neerven, W.L. van, 14:48330
Vermeer, W.J., Mixed-symmetry in the vibrational nucleus ^{142}Ce, 14:48450 (R;AU)
Value of $B(E2;3/2^- \rightarrow 1/2^-)$ for ^7Li, 14:48439 (R;AU)
Yrast 8^+ and 9^+ states of ^{22}Na, 14:48443 (R;AU)
See Lim, C.S., 14:48455
See Pringle, D.M., 14:48438
Vernon, R.J., High power microwave transmission systems for electron cyclotron resonance plasma heating: Volume IV, Progress report, September 1, 1988–August 31, 1989, 14:48672 (R;US)
Vervaet, D., Development of an underwater remote manipulator system for use in TMI-2 [Three Mile Island Unit 2] reactor defueling, 14:47192 (J;US)
Veselov, I.A., ESR study of fast solvate-exchange reactions in oxovanadium (4) β-diketonate solutions, 14:47497 (RA;SU;In Russian)
Veynante, D., *See* Poinsot, T., 14:47657
Vickery, A.M., Atmospheric erosion by impacts: An analytic investigation, 14:48211 (RA;US)
Vieth, W.A., *See* Dunlop, J.A., 14:47555
Vilimpoc, V., SiC-based thin-filament pyrometry: Theory and thermal properties, 14:47702 (BA;US)
Visser, B.M., *See* Smart, J.P., 14:46872
Vitek, V., *See* Carpenter, J.A. Jr., 14:47373
Vlaskin, G.N., Passive neutron verification of WWER-440 spent fuel burnup, 14:47091 (RA;XA)
Vodop'yanov, A.S., *See* Tsyganov, E.N., 14:48745
Vogel, R.A., Implementation and management of waste minimization programs at federal facilities, 14:47213 (RA;US)
Vogl, G., *See* Strasser, G., 14:47427
Vogl, P., 3-D structures and intrinsic defects in trans-polyacetylene, 14:47431 (R;US)

Voisin, P., *See* Bleuse, J., 14:47413
Volf, V., Risk of plutonium: Estimate and control. Biological background and organizational-technical measures, 14:48129 (R;DE;In German)
Volgin, K.Yu., *See* Dudareva, A.G., 14:47515
Volkov, E.D., Peculiarities of surface erosion of Kh13 steel during hydrogen plasma exposure, 14:47368 (RA;SU;In Russian)
Volkov, S.V., NQR and diffuse reflection spectra of rhenium chalcochloride complexes, 14:47510 (RA;SU;In Russian)
See Zub, V.N., 14:47498
Volkov, V.E., *See* Maksimov, N.G., 14:48507
Von Damm, K.L., [Water-rock interaction]: Foreign trip report, August 1–15, 1989, 14:48024 (R;US)
Von Wedel, R.J., *See* Rose, S., 14:48084
Vong, R., Regional analysis of wet deposition for effects research. Project report, 14:47936 (R;US)
Voorhees, L.D., Data and information management system for the ORNL (Oak Ridge National Laboratory) Remedial Action Program, 14:46999 (RA;US)
Voos, M., *See* Bleuse, J., 14:47413
Vosen, S.R., The burning rate of hydroxylammonium nitrate-based liquid propellants, 14:47698 (BA;US)
Vovelle, C., *See* Bastin, E., 14:47562
Vukovic, S., Nonlinear hybrid TE-TM waves in a flowing plasma, 14:48643 (RA;AU)
Vuong Manh Son., Enveloping algebras for a large class of H-algebras, 14:48546 (R;XA)

W

Wach, P., *See* Stollberger, R., 14:48107
Wackerle, J., *See* Forest, C.A., 14:47858
Waddle, D.B., [Energy projects in the Dominican Republic]: Foreign trip report, May 14–26, 1989, 14:47036 (R;US)
Wagh, A.S., Silicate bonded ceramics of laterites, 14:47389 (R;XA)
Wagner, A.F., *See* Dunning, T.H. Jr., 14:47262
See Harding, L.B., 14:47628
Wagner, H.G., *See* Baetz, P., 14:47639
See Bley, U., 14:47537
See Boehm, H., 14:47572
Wagner, J.S., BUCKSHOT simulations of electron beam transport in rectangular IFR [Ion Focused Regime] channels using ATA parameters, 14:47798 (R;US)
Wagner, R.L., Nuclear-target effects in J/psi production in anti p and π^- interactions, 14:48440 (J;NL)
Wahl, M., *See* Jacobs, A., 14:47637
Wai, Y., *See* Silver, E., 14:47850
Waite, D.A., Training requirements for preparing hazardous waste site workers for involvement with mixed waste, 14:46988 (RA;US)
Wakeman, B.H., Evaluation of burnup credit for dry storage casks, 14:46966 (R;US)
Walden, T.L., Thermospray liquid-chromatography mass spectrometry of thiol radioprotective agents: Characteristics spectra. Scientific report, 14:48119 (R;US)
Waldruff, P., *See* Tang, R.T., 14:47967
Walker, A.J., *See* Otlet, R., 14:47959
Walker, D.A., Landscape dynamics in the Arctic foothills: Progress report, July 1, 1988–August 31, 1989, 14:47972 (R;US)
See Walker, M.D., 14:47973
Walker, J.A., *See* Tsang, W., 14:47629
Walker, J.F., *See* Hylton, T.D., 14:48028
Walker, M.D., Wetland soils and vegetation, Arctic Foothills, Alaska, 14:47973 (R;US)
See Walker, D.A., 14:47972
Walker, R.W., Reactions of HO_2 radicals in combustion chemistry, 14:47618 (BA;US)
Walker, V., *See* Rankin, W.N., 14:46955
Walker, W.D., *See* Fortney, L.R., 14:48289
Wallace, D.D., *See* Neulicht, R.M., 14:47948, 14:47949
Wallace, J.S, *See* Witze, P.O., 14:47310
Wallace, W.E., Characterization of surface properties affecting the activity of the 'free silica' fraction of respirable dusts. Final report, 14:47943 (R;US)
Wallner, G., Variant of the thermoluminescence method for sediment age estimation, 14:47473 (RA;AT;In German)
Walsh, P.M., The production and loss of char fines during fluidized bed combustion of a high volatile bituminous coal, 14:46867 (BA;US)
Walston, W.S., The effect of hydrogen on the deformation and fracture of PWA 1480, 14:47381 (BA;US)
Walter, D., *See* Grotheer, H.H., 14:47626
Walter, D.K., *See* Wright, L.L., 14:47030
Walters, C.R., *See* Ashibe, K., 14:48702
Walters, R.A., *See* Modica, L.G., 14:47969
Walton, B.T., Treatability of hazardous chemicals in soils: Volatile and semivolatile organics, 14:48143 (R;US)
Walton, J., High speed balancing applied to the T700 engine. Final report, 14:47776 (R;US)
Wang, C.S., *See* Fawaz, S.A., 14:47412
Wang, C.Y., Seismic analysis of a large pool-type LMR [liquid metal reactor], 14:47132 (R;US)
Wang, E.M., *See* Paige, F.E., 14:48290, 14:48291
Wang, H.Y., *See* Wu, C.K., 14:46861
Wang, Hau H., *See* Williams, J.M., 14:47347
Wang, J., *See* Deluca, E.E., 14:48189
Wang, J.L., LOCA [loss-of-coolant accident] analysis of a proposes power increase for MURR [Missouri University Research Reactor] using RELAP5/MOD2, 14:47199 (J;US)
Wang, J.W., RF properties of periodic accelerating structures for linear colliders, 14:47815 (R;US)
Wang, Jongrong, *See* Wang, Songfend, 14:47200
Wang, Songfend, Assessment of the RETRAN02/MOD3 and RELAP5/MOD2 pressurizer model, 14:47200 (J;US)
Wang, T.Y., *See* Ramachandran, R.S., 14:47758
Wang, X.J., The Brookhaven accelerator test facility injection system, 14:47799 (R;US)
Wanner, H., Modelling interaction of deep groundwaters with bentonite, 14:46961 (RA;US)
Wantuck, P.J., Direct measurements of methoxy removal rate constants for collisions with CH_4, Ar, N_2, Xe, and CF_4 in the temperature range 673-973 K, 14:47627 (BA;US)
Warde, E., *See* Frascaria, R., 14:48348
Wardwell, R.E., Supplemental RI/FS (Remedial Investigation/Feasibility Study) guidance for Federal facilities, 14:47217 (RA;US)
Warnatz, J., *See* Bastin, E., 14:47562
See Maas, U., 14:47687
See Westbrook, C.K., 14:47619
Warpinski, N.R., *See* Lorenz, J.C., 14:46896
Warren, J.B., *See* Sugama, T., 14:47414
Warren, R.G., *See* Drellack, S.L. Jr., 14:47892
Wasilewski, A., Development of electron-photon cascades in lead and layers of lead-scintillator, 14:48489 (RA;PL)
Wasson, J.T., Tektites: Origin as melts produced by the impact of small projectiles onto dry targets, 14:48212 (RA;US)
Watabiki, Yoshiyuki, One-particle-irreducible effective Lagrangian of string modes, 14:48375 (RA;JP)
Watanabe, Hiroyuki, *See* Ikeshima, Yoshiaki, 14:47118
Watanabe, Kazuya., *See* Tomita, Kenji, 14:48223
Watanabe, Tadashi, Stability of numerical solutions for stratified two-phase flow, 14:47751 (R;JP)
Waters, B.J., Overall kinetic parameters for combustion of a highly non-spherical carbon char, 14:47557 (BA;US)
Watkins, D.R., *See* Young, J.D., 14:46941
Watkins, R.D., Field-assisted bonding of single crystal quartz, 14:47446 (R;US)
Watson, A.P., *See* Carnes, S.A., 14:48156
Watson, C.A., *See* Deupree, R.G., 14:47912
Watson, C.T., *See* Hudson, J., 14:46934
Watson, J., Advanced indirect gas-fired heating system. Final report, August 15, 1984-June 30, 1988. Phase 2: Development. Phase 3: Application, 14:46919 (R;US)
Watson, R.E., Electronic structure of transition metal alloys and intermetallics: Charge transfer and its inplications for Moessbauer effect measurements, 14:47331 (R;US)
Watterson, P.A., RMF current drive in cylindrical plasmas - the saga continues, 14:48596 (RA;AU)
See Donnelly, I.J., 14:48604

Watts, R.L., Applications of new technologies using a systems approach, 14:48706 (R;US)
Wawersik, W.R., *See* Morgan, H.S., 14:46983
Wayland, B.B., Catalogic hydrogenation of carbon monoxide: Final progress report, September 15, 1988–September 14, 1989, 14:47024 (R;US)
Wdowczyk, J., *See* Kempa, J., 14:48177
Weaver, H.T., *See* Axness, C.L., 14:47821
Webb, G.A.M., Radiological impact of the Chernobyl reactor accident, on the countries of the European Community, 14:48124 (RA;FR)
Webb, H.A., *See* Bedick, R.C., 14:46879
See McMillian, M.H., 14:47312
Webb, M.L., *See* Namboodiri, M.N., 14:48460
Weber, R., *See* Smart, J.P., 14:46872
Webster-Scholten, C.P., Remedial investigation of the High Explosives Burn Pit facility, Building 829 complex, Lawrence Livermore National Laboratory site 300, 14:47862 (R;US)
Weckman, E.J., The oscillatory behavior of medium-scale pool fires, 14:47651 (BA;US)
Weekly, T.M., Proliferation of chemical weapons: putting the genie back in the bottle. Study project, 14:47321 (R;US)
Wei, J., Microwave instability near transition energy, 14:47792 (R;US)
Wei, J.B., *See* Wu, C.K., 14:46861
Weigold, A.M., *See* McCarthy, I.E., 14:48255
Weigold, E., Electron momentum spectroscopy of molecules: a review of recent developments, 14:48251 (R;AU)
See Frost, L., 14:48252
See Grisogono, A.M., 14:48254
See McCarthy, I.E., 14:48256
See Minchinton, A., 14:48248
Weljo, R.O., *See* Hattrup, M.P., 14:47202
Weller, F.H., *See* Van Deusen, L.C., 14:47003
Weinacht, D.J., PATRAN as an engineering design visualization tool: Design and analysis of a heat exchanger support, 14:47753 (R;US)
See Fales, J.L., 14:48727
Weiner, A.M., *See* Harris, S.J., 14:47564
Weinert, M., *See* Watson, R.E., 14:47331
Weinfurter, H., *See* Badurek, G., 14:48566
Weir, K., *See* Reed, N.R., 14:48150
Weisbin, C.R., *See* Sabharwal, A., 14:48738
Weiss, J.F., Antioxidant mechanisms in radiation injury and radioprotection, 14:48118 (R;US)
Weiss, M., *See* Boehm, H., 14:47572
Weisser, D.C., *See* Catford, W.N., 14:48446
See Orr, N.A., 14:48441
Weltkamp, W.G., Beam diagnostics for the University of Washington superconducting booster, 14:47806 (R;US)
Welch, K.M., Metal and elastomer seal tests for accelerator applications, 14:47804 (R;US)
Refurbishment of the vacuum system of the Brookhaven Alternating Gradient Synchrotron, 14:47801 (R;US)
Weller, F.C., *See* Cable, A.S., 14:46964
Weller, R., *See* Jacobs, A., 14:47637
Wellum, R., *See* Koch, L., 14:47094
Wendt, J.O.L., *See* Bose, A.C., 14:46873
See Scotto, M.V., 14:46866
Wentz, C.A., *See* Martino, L.E., 14:47214
Wergles, K., Radio-, Lyo- and Triboluminesence in $CaCO_3$ and NaCl, 14:47474 (RA;AT;In German)
Wernstedt, K., Wetlands and waste-water management: Questions, answers, advice, and guidance. Technical report, 14:48063 (R;US)
Wesson, J, Tokamaks, 14:48664 (B;US)
Westbrook, C.K., A detailed chemical kinetic reaction mechanism for the oxidation of iso-octane and n-heptane over an extended temperature range and its application to analysis of engine knock, 14:47619 (BA;US)
A kinetic study of ethylene oxidation in a well-stirred reactor, 14:47616 (BA;US)
See Droege, M.W., 14:47018
See Pitz, W.J., 14:47021
Westfall, R.M., *See* Parks, C.V., 14:47195
Westhusing, T.K., Observation of W $\rightarrow \mu\nu$ decays in proton-antiproton collisions at $\sqrt{s}$ = 1.8 TeV, 14:48296 (R;US)
Weston, A.M., *See* Aldis, D.F., 14:47865
Wey, J.E., *See* Quigley, D.R., 14:46803
Whangbo, Myung-Hwan, *See* Williams, J.M., 14:47347
Whealton, J.H., Extraction induced emittance growth for negative ion sources, 14:48668 (R;US)
Whichello, J.W., *See* Evans, P.J., 14:47011
Whitaker, K.W., Role of the turbulent Prandtl number in turbine blade heat transfer prediction, 14:47755 (RA;US)
Whitaker, W.C., *See* St. Clair, G.T., 14:46953
White, A.F., Application of EQ3/6 to modeling the chemical evolution in hydrothermal systems: An example at the Valles Caldera, N.M., 14:47062 (RA;US)
White, C.L., *See* Carpenter, J.A. Jr., 14:47373
White, C.W., *See* Aziz, M.J., 14:47458
White, E.R., Managing the asbestos abatement process, 14:47922 (RA;US)
White, J.E., *See* Ingersoll, D.T., 14:48491
White, J.R., *See* Hull, A.P., 14:47154
White, T.J., *See* Dickson, F.J., 14:47554
White, W.T., Problems mixed wastes pose in implementing RCRA (Resource Conservation and Recovery Act) requirements, 14:46996 (RA;US)
Whitley, J.E., Scottish Universities Research and Reactor Centre annual report 1987-1988, 14:47013 (R;GB)
Whitmire, D.P., Disruption of giant comets in the solar system and around other stars, 14:48213 (RA;US)
Whittaker, W.L., *See* Osborn, J., 14:47194
Wichman, I.S., Continuum-mechanical derivation of the conservation equations for the pyrolysis and combustion of wood. Research report, 14:47029 (R;FI)
Wichner, R.P., Separation of depleted uranium fragments from gun test catchments: Phase 1, Catchment system evaluation and separations methods, 14:46976 (R;US)
Wicke, B.G., The roles of innate oxygen and adsorbed oxygen in the chemistry of soot oxidation by oxygen atoms at 298 K, 14:47575 (BA;US)
Widder, M.E., Kinetic boundary layer on a sphere and the growth of droplets, 14:48262 (RA;AT;In German)
Wiedermann, A.H., *See* Shin, Y.W., 14:47099
Wiehe, J., *See* Hollis, D.J., 14:47870
Wieschnowsky, U., Some new observations concerning the mass growth of soot in premixed hydrocarbon-oxygen flames, 14:47565 (BA;US)
Wiesinger, G., Unstable magnetic order in intermetallic compounds, 14:47356 (RA;AT;In German)
Wiesler, D.G., Spin fluctuations and excitations in a 2D xy-ferromagnet: CoClsub 2 in graphite, 14:48496 (R;US)
Wihersaari, M., *See* Staahlberg, P., 14:47020
Wilbur, P.J., *See* Williams, J.D., 14:48657
Wilczek, F., *See* Turner, M.S., 14:48216
Wild, E., *See* Wallner, G., 14:47473
Wilde, P., Collisions with ice-volatile objects: Geological implications, 14:48214 (RA;US)
Wilde, R.T., *See* Yeasted, J.G., 14:47222
Wilding, M., *See* Kaufmann, M., 14:48712
Wilhelmy, J., *See* Namboodiri, M.N., 14:48460
Wilkes, K.E., Model for roof thermal performance, 14:47270 (R;US)
Wilkinson, C.A., *See* Haines, T.J., 14:48183
Wilkinson, V.K., Life cycle cost analyses of US Air Force heating plants, 14:47208 (R;US)
Williams, E.L., Southern California Air Quality Study: Peroxyacetyl nitrate (PAN) measurements. Final report, 14:47941 (R;US)
Williams, F.A., *See* Li, S.C., 14:47706
See Peters, N., 14:47578
See Rogg, B., 14:47663
Williams, G.P., The national synchrotron light source and its applications, 14:47781 (R;US)
Williams, J.C., *See* Walston, W.S., 14:47381
Williams, J.D., Space plasma contractor research, 1988. Annual report, 1 January 1988-1 January 1989, 14:48657 (R;US)

Williams, J.M., Structure-property relationships as an aid in the rational design of β-$(ET)_2X$ organic superconductors, 14:47347 (R;US)
Williams, J.R.A., *See* Cable, A.S., 14:46964
Williams, L.C., Implementation of a customizable instruction editing and delivery system, 14:48721 (R;US)
See Broadaway, E.R., 14:48722
See Van Hoesen, S.D., 14:46945
Williams, L.R., An approach to remedial action decisions on sites which are marginally contaminated with Radium-226, 14:47004 (R;US)
Williams, M., *See* Yamada, T., 14:47919
Williams, R.G., *See* Truelove, J.S., 14:46857
Williamson, A.D., Development of sampling methods for source PM10 emissions. Final report, 14:47951 (R;US)
Williamson, W. Jr., *See* Ozturk, N., 14:48529
Willis-Richards, J., Camborne geothermal energy project 2C-7 resource evaluation. V. 1. Overview, 14:47053 (R;GB)
Camborne geothermal energy project 2C-7 resource evaluation. V. 3. Gravity and thermal modelling, 14:47055 (R;GB)
Willms, R.S., *See* Anderson, J.L., 14:47166
Wilson, B.W., *See* Pyne, J.W., 14:46804
Wilson, C.N., Studies on spent fuel dissolution behavior under Yucca Mountain repository conditions, 14:46980 (R;US)
Wilson, D.J., Error introduced into a water density measurement due to the presence of a water density gradient, 14:47971 (R;AU)
Soil cleanup by in situ surfactant flushing. I. Mathematical modeling and lab scale results, 14:47980 (RA;US)
Wilson, R.M., *See* Rockwell, R.J., 14:47939
Wilson, R.P. Jr., *See* Rao, A.K., 14:47313
Wilson, W.B., Calculated proton-induced thick-target neutron and radionuclide yields for $E_p \leq 100$ MeV, 14:48474 (R;US)
Wiltgen, M., *See* Gell, G., 14:48104
Wilzbach, K.E., *See* Doctor, R.D., 14:46825
Winans, R.E., Multiple heteroatom containing sulfur compounds in coals, 14:46832 (R;US)
Wingert, V.L., Programmatic changes due to TMI-2 [Three Mile Island Unit 2]: Accident planning, 14:47187 (J;US)
Winn, K.R., *See* Wantuck, P.J., 14:47627
Winograd, N., Studies on ions and neutrals desorbed from solid surfaces by ion and electron bombardment. Final report, 1 November 1984-31 October 1988, 14:48494 (R;US)
Winschel, R.A., Coal liquefaction process solvent characterization and evaluation: Technical progress report, July 1–September 30, 1988, 14:46818 (R;US)
See Burke, F.P., 14:46793
Winske, D., Short wavelength striations on expanding plasma clouds, 14:48242 (R;US)
See Gary, S.P., 14:48241
See Jones, M.E., 14:48655
See Thomas, V., 14:48184
Wippel, V., *See* Abt, R., 14:47423
Wischow, T.G., *See* Bourqeois, B.S., 14:48717
Wise, M.L., *See* Rensberger, K.J., 14:47466
Withers, R.S., Comparison of superconductive and surface-acoustic-wave signal processing, 14:47763 (R;US)
Witherspoon, P.A., *See* Persoff, P., 14:46894
Witt, B., *See* Brand, M., 14:47255
Witte, M.C., *See* Bumpus, S.E., 14:47729
Witze, P.O., Fiber-optic instrumented spark plug for measuring early flame development in spark ignition engines, 14:47310 (B;US)
Linear fiber-optic array for measuring the transient propagation of a premixed-charged flame, 14:47701 (BA;US)
Wobig, H., On bootstrap currents in toroidal systems, 14:48644 (R;DE)
Woerner, M.C.H., *See* Woolsey, G.A., 14:48179
Wohletz, K.H., *See* Brown, J.A., 14:47910
Wohlpart, A., *See* Gumnick, J.L., 14:46989
Wojtowicz, M., *See* Suuberg, E.M., 14:47559
Wold, A., *See* Niu, C.M., 14:47387
Wolery, T.J., EQ3/6 - Status and future development, 14:46959 (RA;US)
Wolfe, R.F., *See* Shoemaker, E.M., 14:48208
Wolfe, W.H., Epidemiologic investigation of health effects in Air Force personnel following exposure to herbicides. Summary mortality update, 1989. Interim report 1979-1987, 14:48113 (R;US)
Wolfram, J.H., *See* Chapatwala, K.D., 14:47224
Wolfrum, J., *See* Jacobs, A., 14:47637
See Schwarzwald, R., 14:47661
Wong, C.C., *See* Stamps, D.W., 14:47151
Wong, Cheuk-Yin, [International conference on nuclear physics]: Foreign trip report, May 20, 1988–August 31, 1988, 14:48482 (R;US)
Wood, R.F., [Origins of high-temperature superconductivity in the new copper oxide based ceramic superconductors]: Foreign trip report, July 20, 1988–July 29, 1989, 14:48534 (R;US)
Woods, C.L., *See* Catford, W.N., 14:48446
See Orr, N.A., 14:48441, 14:48442
Woodside, J., *See* Boudjema, F., 14:48325
Woodward, E.C. Jr., Breathing on the Mesa, 14:47903 (RA;US)
Woolsey, G.A., Laser Doppler measurements of corona wind velocity, 14:48179 (RA;AU)
See Lamb, D.W., 14:48238
Wooster, T.T., *See* Geng, L., 14:47535
Wooton, R.O., MARCH calculations performed for the TMI-2 [Three Mile Island Unit] analysis exercise program, 14:47167 (J;US)
Wornat, M.J., Pyrolysis-induced changes in the ring number composition of polycyclic aromatic compounds from a high volatile bituminous coal, 14:46855 (BA;US)
Worthington, P.R., *See* Stamps, D.W., 14:47151
Wrbanek, J., *See* Bross, A., 14:47807
Wright, C.A., Utility of surface-floating Vhironomidae pupal exuviae in assessing the impact of PCBs on two stream communities. Technical report, 14:48036 (R;US)
Wright, I.F., *See* Vermeer, W.J., 14:48443
Wright, J.D., Design of direct-contact preheater/boilers for solar pond power plants, 14:47045 (BA;US)
Wright, L.L., Biomass energy for Mississippi, 14:47030 (R;US)
Wright, W., Laser induced fluorescence on the TORTUS tokamak, 14:48601 (RA;AU)
Wroblewski, A., Constraints on multiplicity distribution of quark pairs, 14:48341 (RA;PL)
Wu, C.K., The use of nonsymmetrical jets for the stabilization of low grade coal flames, 14:46861 (BA;US)
Wu, C.M., *See* Robin, A.M., 14:46816
Wu, Chengchi, *See* Wang, Songfend, 14:47200
Wu, R.M., *See* Albrecht, R.W., 14:47124
Wu, Ting-shu, Evaluation of LMR [liquid metal reactors] core support concepts under seismic events, 14:47131 (R;US)
Wuchte, T.J., Visibility in an atmospheric nuclear dust cloud. Master's thesis, 14:47867 (R;US)
Wuerz, H., *See* Simon, G.G., 14:47092
Wurz, D., *See* Blaser, P., 14:47071
Wutte, D., *See* Hilscher, G., 14:47357
Wylie, A.N., *See* Van Hoesen, S.D., 14:46945
Wyllie, H.A., Production of ultra-thin layers of ion-exchange resin and metallic silver by electrospraying, 14:47012 (R;AU)
Wythe, D.M., *See* Latorre, V.R., 14:47842
Wyza, R.E., Depolymerization of low-rank coals by a unique microbial consortium, 14:46801 (RA;US)

X

Xu, S., Studies of near-spherical plasma discharges in an inexpensive rotamak, 14:48620 (RA;AU)
Theoretical study of RF current drive in the rotamak, 14:48597 (RA;AU)
See Brotherton-Ratcliffe, D., 14:48625

Y

Yablokov, Yu.V., *See* Akhmin, S.M., 14:47486
Yager, R.E., Hydrologic evaluation of seven proposed cap designs, 14:46951 (RA;US)

Yamada, T., A desk-top computer forecast for emergency response planning, 14:47919 (R;US)
Air quality studies in the western United States, 14:47925 (R;US)
Yamada, Yasuhiko, Representation theory of current algebra and conformal field theory on Riemann surfaces, 14:48409 (RA;JP)
Yamaguchi, Hiroshi, Beam loss monitor for the KEK PS-Booster synchrotron, 14:47811 (R;JP;In Japanese)
Yamaguchi, Yuji, 3-dimensional non-linear resistive MHD code using semi-implicit method, 14:48652 (R;JP;In Japanese)
Yamamoto, Hiroshi, *See* Katoh, Toshio, 14:48433
Yamamoto, Soichi, *See* Sadakata, Masayoshi, 14:46860
Yamamoto, Tadatoshi, *See* Takebe, Shinichi, 14:47993
Yamamura, Hidemasa, Thermal design of a 10-kW helium refrigerator, 14:48687 (R;JP;In Japanese)
Yamane, Isao, *See* Yamaguchi, Hiroshi, 14:47811
Yamanishi, T., Single column and two-column H-D-T distillation experiments at TSTA, 14:48700 (J;US)
See Anderson, J.L., 14:47166
Yamaoka, Ichiro, Extinction of near-stoichiometric flames diluted with nitrogen in a stagnation flow, 14:47675 (BA;US)
Yanase, Nobuyuki, *See* Moriuchi, Shigeru, 14:47961
Yang Lu, *See* Zhang Jingzhong, 14:48542
Yang, A.B., *See* Arko, A.J., 14:48531
Yang, J.C., The combustion of unsupported heptane/hexadecane mixture droplets at low gravity, 14:47711 (BA;US)
Yang, Sung-Kil., *See* Eguchi, Tohru, 14:48363
Yang, Wen K., [Endogenous retrotransposable gene elements af human genome in high incidence cancers]: Foreign trip report, December 6, 1988–March 6, 1989, 14:48090 (R;US)
Yankina, L.F., *See* Minin, V.V., 14:47490
Yannitell, D.M., Preparation, lifting and loading of the Shippingport Reactor Pressure Vessel/Neutron Shield Tank Package, 14:47134 (R;US)
Yariv, A., High power semiconductor laser sources. Final report, 14:47740 (R;US)
Yarmoff, J.A., *See* Lince, J.R., 14:48495
Yasue, Y., *See* Ohtani, S., 14:48516
Yates, M.V., *See* Cochran, J.W., 14:48031
Yeager, D.L., Multiconfigurational Green's function approaches in quantum chemistry, 14:47416 (RA;US)
Yeasted, J.G., Complex environmental requirements compel logical approach: The CERCLA Comprehensive Environmental Response, Compensation, and Liability Act) framework at Fernald, 14:47222 (RA;US)
Yeazel, J.A., *See* Croft, L.D., 14:47198
Yeh, G.T., [Groundwater movement models: A review]: Foreign trip report, June 14–17, 1989, 14:48023 (R;US)
[Review three interim reports on numerical modeling, tracer study, and monitoring design]: Foreign trip report, January 18–27, 1989, 14:46971 (R;US)
Yeh, H.C., Improved silicon nitride for advanced heat engines. Annual contractor report, 14:47395 (R;US)
Yesavage, V.F., *See* Sandarusi, J.A., 14:47851
Yetter, R.A., Chemical kinetic modeling and sensitivity analyses for boron assisted hydrocarbon combustion, 14:47622 (BA;US)
Yip, B., *See* Long, M.B., 14:47599
Yogesh, G.P., *See* Raghunandan, B.N., 14:47669
Yokomura, Takeyoshi., *See* Ambo, Noriaki, 14:47102
Yonnet, J., *See* Frascaria, R., 14:48348
York, T., Fragmentation of cosmic-string loops, 14:48190 (R;US)
Yoshida, Akira, Structure of opposed jet premixed flame and transition of turbulent premixed flame structure, 14:47666 (BA;US)
Yoshida, H., *See* Anderson, J.L., 14:47166
See Shimizu, H., 14:48295
See Yamanishi, T., 14:48700
Yoshida, Kenzou, *See* Nakamura, Yoshiteru, 14:47015
Yoshimura, K., *See* Hilscher, G., 14:47357
Yoshino, Ryuji, *See* Kamada, Yutaka, 14:48654
Yoshio, M., Production of EMD (electrolytic manganese dioxide) under different gas atmospheres and its application as a cathode material for lithium secondary batteries, 14:47206 (R;JP)
Young, B.C., *See* McCollor, D.P., 14:46849
Young, G.R., Results from WA80 on transverse energy production, fluctuations in multiparticle production, and γ/π^0 ratios, 14:48444 (J;NL)
[Lead beams at CERN SPS synchrotron]: Foreign trip report, January 30, 1989–February 3, 1989, 14:47788 (R;US)
[Sulfur 32 beams on the CERN SPS synchrotron]: Foreign trip report, November 1–2, 1988, 14:47787 (R;US)
[WA80 collaboration, Muenster, W. Germany, April 17–21, 1989]: Foreign trip report, 14:47836 (R;US)
See Awes, T.C., 14:47796
See Obenshain, F.E., 14:47834
Young, J.D., Remedial technology screening method, 14:46941 (RA;US)
Young, J.O., Development of the Regional Oxidant Model version 2.1. Interim report, January 1988-April 1989, 14:47954 (R;US)
Young, P.G., *See* Wilson, W.B., 14:48474
Youngreen, M.A., Updating nuclear effects in theater models. Final report, 14:47869 (R;US)
Younus, M., Preliminary radiological consequence estimate for a reference LEU core for PARR, 14:47117 (R;PK)
Yu Lu., *See* Chen Hao, 14:48530
Yu, I.I.K., *See* Kyrala, G.A., 14:47719
Yu, S.K.T., *See* Thomson, J.S., 14:46836
Yuasa, Saburo, Ignition and combustion of metals in a carbon dioxide stream, 14:47683 (BA;US)
Yudelev, M., *See* Jones, D.T.L., 14:47832
Yunus, A., *See* Talukdar, B., 14:48469
Yurteri, R., Bacterial desulfurization of Turkish lignites, 14:46808 (RA;US)

Z

Zabel, H., *See* Wiesler, D.G., 14:48496
Zabolotnyj, V.T., *See* Babaev, V.P., 14:48512
Zabolotskaya, E.V., *See* Kurbatova, L.D., 14:47476
Zabriskie, W.L., *See* Broadaway, E.R., 14:48722
Zabrodin, A.V., Action for a non-Archimedean string and Brua-Tits trees, 14:48407 (RA;SU;In Russian)
Zadra, A., *See* Abdalla, E., 14:48540
Zaebst, D., *See* Matanoski, G., 14:47956
Zafindratafa, G., Few remarks on anti-invariant quasiumbilical submanifolds, 14:48556 (R;XA)
Zafindratafa, G.K., Survey on conformal flatness and quasiumbilicity of submanifolds, 14:48555 (R;XA)
Zaiss, F., Toxic Release Inventory (TRI), United States and Territories, 1987 (DBASE III) (for microcomputers). Data file, 14:48115 (R;US)
Toxic Release Inventory (TRI), United States and territories, 1987 (Lotus 1-2-3) (for microcomputers). Data file, 14:48116 (R;US)
Zajkin, Yu.A., Temperature and amplitude dependence of internal friction in tantalum, niobium, dysprosium irradiated with electrons, 14:47366 (RA;SU;In Russian)
Zajtsev, S.V., *See* Babaev, V.P., 14:48512
Zakharov, A.V., *See* Veselov, I.A., 14:47497
Zakharov, V.N., *See* Sujsalu, A., 14:47500
Zaletnov, V.G., *See* Dorokhova, N.I., 14:47488
Zalewski, K., Baryon charges of chiral bags, 14:48334 (RA;PL)
Zamanskii, V.M., *See* Borisov, A.A., 14:47620
Zanelli, S., *See* Tognotti, L., 14:46862
Zapotosky, J.E., ELF (extremely low frequency) communications system ecological monitoring program: Summary of 1987 progress. Technical report, 1 January-31 December 1987, 14:48159 (R;US)
Zeer, Eh.P., Study of dynamic processes during phase transition in $ATiF_6$ center dot $6D_2O$ crystals, 14:47525 (RA;SU;In Russian)
Zeitlin, B.A., *See* Kanithi, H.C., 14:47732
Zelenskij, V.F., *See* Arbuzov, V.L., 14:47361
Zeman, H., *See* Thompson, A.C., 14:47459
Zhan, H.Q, *See* Wu, C.K., 14:46861
Zhanf, S.Y., *See* Zhang, W., 14:47802
Zhang Jingzhong, What can we do with only a pair of rusty compasses, 14:48542 (R;XA)
Zhang, W., Test fast kicker pulser, 14:47802 (R;US)

Zhang, X., *See* McCarthy, I.E., 14:48256
Zhao, Baochang, High pressure combustion characteristics of RDX (cyclotrimethylene trinitramine) based propellants, 14:47700 (BA;US)
Zhao, H., *See* Coats, C.M., 14:47597
Zhao, Zhijian, *See* Zhao, Baochang, 14:47700
Zheng, Y., *See* McCarthy, I.E., 14:48256
Zheng, YAN, *See* Qin-Wen, ZHANG, 14:48215
Zhou, P., *See* Graff, R.A., 14:46817
Zhou, Y., Equations of state for hard-sphere fluids, 14:47759 (J;US)
Zhu, F.Y., *See* Wu, C.K., 14:46861
Zhu, P., Optical gain in BASIL II at the lower hybrid resonance, 14:48605 (RA;AU)
Zhurkin, A.B., *See* Golovashkin, A.I., 14:47394
Ziatdinov, A.M., *See* Karasev, V.E., 14:47509
Ziegler, N.F., [Discharges and electrical insulation in vacuum, Paris, France, June 27–30, 1988 and visit to Strasbourg, France, July 4, 1988]: Foreign trip report, 14:47814 (R;US)
Zigler, G., *See* Keller, C., 14:47882
Zimmer, J., Investigations of vapour explosions with alumina-droplets in sodium, 14:47145 (R;DE;In German)
Zimmerman, M.G., Characterization of sediment in a leaching trench RCRA (Resource Conservation and Recovery Act) site, 14:46990 (RA;US)
Zimmerman, R.S., Static tensile and tensile creep testing of five ceramic fibers at elevated temperatures, 14:47397 (R;US)
Strain energy release rate as a function of temperature and preloading history utilizing the edge delamination fatique test method. Contractor resepor, July 1986-October 1988, 14:47441 (R;US)
Zinkle, S.J., [US-Japan workshop on small specimen test techniques, Tokyo, Japan, and visits to Sapporo, Fukuoka, and Nagoya, Japan, February 17–25, 1988]: Foreign trip report, 14:47372 (R;US)
Zinn, B.T., *See* Sankar, S.V., 14:47658
Zirps, N.A., Waste minimization at Vandenberg Air Force Base - cast studies, 14:47215 (RA;US)
Zlochower, I.A., *See* Cashdollar, K.L., 14:46842
Zoller, W.H., *See* Finnegan, D.L., 14:48196
Zolotukhina, L.V., ESR in hydrated lithium and sodium dodecavanadates with vanadium mixed oxidation, 14:47491 (RA;SU;In Russian)
Zub, V.N., Investigation of processes of $NbCl_5$ complexing with β-diketones, 14:47498 (RA;SU;In Russian)
Zurliene, W.G., *See* Ruhter, P.E., 14:47169
Zwick, T.C., *See* Arthur, M.F., 14:47978
Zwicky, H.U., Determination of radial gadolinium burnup in LWR fuel by secondary ion mass spectrometry (SIMS), 14:47478 (RA;XA)
See Blanpain, P., 14:47089
Zyman, J., *See* Botts, J.A., 14:48045

Subject Index

This index is arranged by subject descriptors selected from those assigned to each citation in this publication. Subject descriptors are selected from a controlled thesaurus of terms, *EDB Subject Thesaurus* (DOE/OSTI-7000). In order to enhance indexing, subject descriptor entries generally consist of a pair of descriptors: a main term and a qualifier term. Each entry includes the full title (which may be followed by supplementary descriptive information in parentheses) and the citation number. Additional information given in parentheses indicates the document type (an abbreviation such as B for book), the country of publication (such as DE for Federal Republic of Germany), and the language if non-English.

See references guide users from synonymous terms to the descriptors selected for the concept. *See also* references indicate subject concepts that are more specific than a particular descriptor. To gain complete subject coverage, all such terms should be reviewed.

A

A RESONANCES
See MESONS

A-BOMB SURVIVORS
Spontaneous genomic instability in humans: Final report, 14:48086 (R;US)

A2H-1320 RESONANCES
See MESONS

A2L-1280 RESONANCES
See MESONS

ABANDONED SITES
Results of the radiological survey at 142 West Central Avenue, Maywood, New Jersey (MJ041), 14:47998 (R;US)
Results of the radiological survey at 205 Main Street, Lodi, New Jersey (LJ075), 14:47996 (R;US)
Results of the radiological survey at 88 East Central Avenue, Maywood, New Jersey (MJ037), 14:47997 (R;US)
Results of the radiological survey at 9 Redstone Lane, Lodi, New Jersey (LJ069), 14:47995 (R;US)

ABSORBED DOSES
See RADIATION DOSES

ABSORPTION
Kinetic boundary layer of the linearized Boltzmann equation at a partly absorbing sphere, 14:48260 (RA;AT;In German)

ACCELERATOR FACILITIES
[Discharges and electrical insulation in vacuum, Paris, France, June 27–30, 1988 and visit to Strasbourg, France, July 4, 1988]: Foreign trip report, 14:47814 (R;US)

ACCELERATORS
Superconducting shielded PYX PPM (periodic permanent magnet) stacks, 14:47734 (P;US)
Superconducting shielded PYX PPM stacks, 14:47733 (P;US)

ACCESS DENIAL SYSTEMS
See ENTRY CONTROL SYSTEMS

ACCUMULATION (RADIOECOLOGICAL)
See RADIOECOLOGICAL CONCENTRATION

ACES
See QUARKS

ACETATES
Biological conversion of synthesis gas into liquid fuels, 14:46800 (RA;US)

ACETYLCHOLINE
Isolating a cell maximally secreting acetylcholinesterase. Annual report, 31 January 1984-30 January 1985, 14:48084 (R;US)
Radioimmunoassay for pyridostigmine, 14:48085 (R;US)

ACETYLENE
A theoretical analysis of the reaction between hydroxyl and acetylene, 14:47631 (BA;US)
Discussion of two-photon laser-excited fluorescence as a method for quantitative detection of oxygen atoms in flames, 14:47467 (BA;US)
Dynamic effects of autoignition centers for hydrogen and $C_{1,2}$-hydrocarbon fuels, 14:47686 (BA;US)
Experimental and computational investigation of the structure of a sooting C_2H_2-O_2-Ar flame, 14:47562 (BA;US)
Flame-jet ignition of large fuel-air clouds, 14:47655 (BA;US)
Kinetics of the reactions of chlorinated alkynes with atomic oxygen: The application of a new experimental technique, 14:47920 (BA;US)
Radiative properties of chain-agglomerated soot formed in hydrocarbon diffusion flames, 14:47647 (BA;US)
Reactions of vinyl and phenyl radicals with ethyne, ethene and benzene, 14:47630 (BA;US)
The formation of polyhedral carbon ions in fuel-rich acetylene and benzene flames, 14:47571 (BA;US)
The influence of pressure and temperature on soot formation in premixed flames, 14:47572 (BA;US)

ACID MINE DRAINAGE
Evaluation of an equilibrium speciation model for the acid aqueous iron sulfate system at 25°C, 14:46838 (RA;US)

ACID RAIN
Flexible Regional Emissions Data System (FREDS) documentation for the 1985 NAPAP (National Acid Precipitation Assessment Program) emissions inventory. Final report, 14:47969 (R;US)
Materials Aerometric data base for use in developing materials damage functions, 14:47967 (R;US)
Paint coatings: Controlled field and chamber experiments, 14:47947 (R;US)
Regional analysis of wet deposition for effects research. Project report, 14:47936 (R;US)

ACIDIFICATION
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ACIDITY
See PH VALUE

ACQUISITION (DATA)
See DATA ACQUISITION

ACTINIDE ISOTOPES
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Geologic containment of radioactive waste, 14:46969 (R;US)

ACTIVATED CARBON
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ADGEZATOR
See ELECTRON-RING ACCELERATORS

AERIAL MONITORING
Discussion on emergency aerial survey system for practical use. Survey technique, system, operation and management, 14:47961 (R;JP;In Japanese)

AERIAL SURVEYING
Fault detection and reliability of the GASS (Geophysical Airborne Survey System) multiprocessor survey system, 14:48717 (R;US)

AEROSOLS
Flame-jet ignition of large fuel-air clouds, 14:47655 (BA;US)
Fog, cloud, and dew chemistry. Final report, 14:47940 (R;US)

Real time measurement of combustion aerosol size distributions, 14:47778 (R;FI;In Finnish)
Roles of pH, titratable acid, and specific chemical composition in mediating effects of acid aerosols on the airways. Final report, 14:48147 (R;US)

AGRICULTURE
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Energy study of the agricultural industry, 14:47288 (R;NL;In (In Dutch))

AIR
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AIR FLOW
GEOTOX multimedia compartment model user's guide supplement, 14:48288 (R;US)
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AIR POLLUTION
Chemical Mass Balance (CMB) Receptor Model (Version 6.0) (for microcomputers). Model-Simulation, 14:47935 (R;US)
Development of sampling methods for source PM10 emissions. Final report, 14:47951 (R;US)
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Materials Aerometric data base for use in developing materials damage functions, 14:47967 (R;US)
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AIR-FUEL RATIO
See FUEL-AIR RATIO

AIRBORNE PARTICLES
See PARTICULATES

AIRBORNE PARTICULATES
See PARTICULATES

AIRCRAFT
SNRS [stationary neutron radiography system] component positioning systems, 14:47730 (J;US)

AIRTIGHTNESS
Federal policy options for indoor air pollution from combustion appliances. Technical report, 14:47968 (R;US)

ALARA
Overview, what is ALARA, 14:47158 (BA;US)

ALARM DOSEMETERS
See RADIATION MONITORS

ALASKA GAS PIPELINE
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ALDEHYDES
Polymerization and decarbonylation reactions of aldehydes on the Pd(111) surface, 14:47528 (J;US)

ALDEHYDO ACIDS
See ALDEHYDES

ALEUTIAN ISLANDS
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ALFVEN WAVES
Alfven waves in TORTUS, 14:48636 (RA;AU)
Fast Alfven eigenmodes in the TORTUS tokamak, 14:48635 (RA;AU)
Observation of m = +- 1 MHD surface waves and shear Alfven waves converted from surface waves, 14:48642 (RA;AU)

ALGAE
Seasonal dynamics of ^{60}Co uptake by freshwater algae under natural conditions, 14:48047 (R;FR;In French)

ALGEBRA
Classification of modular invariant partition functions for the twisted N=2 superconformal algebra, twisted SU(2) Kac-Moody algebra and D_{2K} parafermions, 14:48389 (R;XA)
Enveloping algebras for a large class of H-algebras, 14:48546 (R;XA)
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ALKALI METAL COMPOUNDS
^{127}I NQR study of holmium iodide compounds with monovalent metals (Metals: K, Rb, Cs, Ag, Tl.), 14:47515 (RA;SU;In Russian)

ALKALI METALS
Increased SO_2 removal with the addition of alkali metals and chromium to calcium-based sorbents, 14:46876 (BA;US)

ALKALINE EARTH METAL COMPOUNDS
Complexone application to sample preparation for an x-ray fluorescence analysis, 14:47475 (RA;SU;In Russian)

ALKANES
Reactions of HO_2 radicals in combustion chemistry, 14:47618 (BA;US)

ALKYL RADICALS
Preparation, properties, and crystal structure of a novel series of macrocyclic organocobalt complexes, 14:47533 (J;US)

ALLOY SU31
See NIOBIUM BASE ALLOYS

ALLOY-50KH4N6G12F2V
See CHROMIUM ALLOYS

ALLOY-60T
See TITANIUM BASE ALLOYS

ALLOY-79NM
See NICKEL BASE ALLOYS

ALLOY-B-66
See NIOBIUM BASE ALLOYS

ALLOY-B-88
See NIOBIUM BASE ALLOYS

ALLOY-C-129Y
See NIOBIUM BASE ALLOYS

ALLOY-CB-1
See NIOBIUM BASE ALLOYS

ALLOY-CB-752
See NIOBIUM BASE ALLOYS
ALLOY-D-43
See NIOBIUM BASE ALLOYS
ALLOY-DH-245
See NIOBIUM BASE ALLOYS
ALLOY-FS-85
See NIOBIUM BASE ALLOYS
ALLOY-GE
See COPPER ALLOYS
ALLOY-GMR-235
See NICKEL BASE ALLOYS
ALLOY-HD-8077
See NICKEL BASE ALLOYS
ALLOY-KH20N80T
See NICKEL BASE ALLOYS
ALLOY-KHN77TYU
See NICKEL BASE ALLOYS
ALLOY-M-252
See NICKEL BASE ALLOYS
ALLOY-MA-754
See NICKEL BASE ALLOYS
ALLOY-MA-956
See IRON BASE ALLOYS
ALLOY-MM-0011
See NICKEL BASE ALLOYS
ALLOY-TI90AL6V4
Threshold for fatigue crack propagation, 14:47348 (R;DE;In German)
ALLOY-VT6
See ALLOY-TI90AL6V4
ALLOY-VTZ-1
See TITANIUM BASE ALLOYS
ALLOY-VUS-6
See NIOBIUM BASE ALLOYS
ALLOY-WAZ-16
See NICKEL BASE ALLOYS
ALLOYS
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ALPHA DECAY RADIOISOTOPES
Ultrapure materials for alpha particle-sensitive applications, 14:47555 (J;US)
ALPHA-BEARING WASTES
Remote-handled transuranic solid waste characterization study: Oak Ridge National Laboratory, 14:46975 (R;US)
ALPS
Vertical distribution of the Chernobyl fallout in snow profiles, 14:47992 (RA;AT;In German)
ALUMINIA
See ALUMINIUM OXIDES
ALUMINIUM
Effects of acid and aluminum on swim bladder development and yolk absorption in the fathead minnow, pimephales promelas, (journal version), 14:48146 (R;US)
Ignition and combustion of metals in a carbon dioxide stream, 14:47683 (BA;US)
Metals in intimate contact, 14:47336 (RA;US)
Physical chemistry of carbothermic reduction of aluminum: Final report, 14:47485 (R;US)
Polishing methods for metallic and ceramic transmission electron microscopy specimens: Revision 1, 14:47329 (R;US)
Polyelectrolyte-diffused zinc phosphate conversion coatings and polyacid coupling primers for corrosion protection of steel and aluminum, and alkali-catalyzed hydrolysis of polyimide-based materials: Final report, 14:47414 (R;US)
Structural stability calculations for films and crystals, 14:47345 (RA;US)
ALUMINIUM 27 TARGET
Results from WA80 on transverse energy production, fluctuations in multiparticle production, and γ/π^0 ratios, 14:48444 (J;NL)
ALUMINIUM ALLOYS
Materials by design, 14:47380 (BA;US)
Spin fluctuations and weak itinerant ferromagnetism in $Y(Co_{1-x}Al_x)_2$ $(0,00<x\leq0,18)$, 14:47357 (RA;AT;In German)
The HEL [Hugoniot Elastic Limit] and rate-dependent yield behavior, 14:47370 (R;US)
Weldability of ductile nickel aluminides, 14:47374 (R;US)
ALUMINIUM NITRIDES
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ALUMINIUM OXIDES
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Extended fine structure in appearance potential spectroscopy as a probe of solid surfaces, 14:47339 (RA;US)
Static tensile and tensile creep testing of five ceramic fibers at elevated temperatures, 14:47397 (R;US)
ALUMINUM
See ALUMINIUM
AMERICIUM 241
Studies of the conversion-chemistry of plutonium and uranium in the nitrate- and carbonate-systems. Final report, 14:47548 (R;DE;In German)
AMERICIUM COMPOUNDS
Studies on rapid ion-exchange separation of the transplutonium elements with mineral acid-methanol mixed media, 14:47553 (R;JP)
AMMONIA
Ambient water-quality criteria for ammonia (salt water)-1989, 14:48074 (R;US)
Equilibrium computations of multiphase nonideal electrolytic systems and structure of turbulent reacting dissolving jets, 14:47601 (BA;US)
High temperature study of the reaction of $O(^3P) + NH_3$, 14:47482 (R;US)
The reduction of NO_x emissions from a fluidized bed combustor by staged combustion combined with ammonia addition, 14:46875 (BA;US)
AMMONIUM COMPOUNDS
Inclusion tuning of nonlinear optical materials: Sorbates in the KTP structure, 14:47529 (J;US)
AMMONIUM NITRATES
The burning rate of hydroxylammonium nitrate-based liquid propellants, 14:47698 (BA;US)
AMYL ALCOHOLS
See PENTANOLS
ANAEROBIC DIGESTION
Anaerobic digestion: Annual report, FY 1988, 14:47027 (R;US)
ANALOG RESONANCES
See RESONANCE
ANALYSIS (THERMAL)
See THERMAL ANALYSIS
ANGIOGRAPHY
See BLOOD VESSELS
ANIMAL BREEDING
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ANIMAL CELLS
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ANSTO
ANSTO resources, 14:48710 (R;AU)
ANSTO strategic plan 1988-1993, 14:48709 (R;AU)
Annual report 1987-1988, 14:47141 (R;AU)
ANTARCTIC REGIONS
Multipoint measurements from substorm onset to recovery: The relation between magnetic pulsations and plasma-sheet thickening, 14:48236 (R;US)
Search for the Tunguska event in the Antarctic snow, 14:48206 (RA;US)

ANTHRACENE
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ANTHRACITE
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ANTIFOULANTS
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ANTIMONY
Boiling of geothermal waters: precipitation of base and precious metals, speciation of arsenic and antimony, and the role of gas phase metal transport, 14:47060 (RA;US)
ANTIMONY COMPOUNDS
Energy relaxation of light holes in $InAs_{.15}Sb_{.85}/InSb$ multiple quantum wells, 14:48523 (R;US)
ANTIOXIDANTS
Antioxidant mechanisms in radiation injury and radioprotection, 14:48118 (R;US)
ANTIPROTON REACTIONS
Nuclear-target effects in J/psi production in anti p and π^- interactions, 14:48440 (J;NL)
ANTIPROTONS
Falling antimatter: An experiment to measure the gravitational acceleration of the antiproton, 14:48359 (J;NL)
ANTRIM SHALES
See BLACK SHALES
APPARATUS
See EQUIPMENT
APPLIANCES
Federal policy options for indoor air pollution from combustion appliances. Technical report, 14:47968 (R;US)
Technical support document: Energy conservation standards for consumer products: Dishwashers, clothes washers, and clothes dryers including Environmental Assessment (DOE/EA-0386) Regulatory Impact Analysis, 14:47264 (R;US)
APPLICATORS (RADIOTHERAPY)
See RADIATION SOURCES
AQUATIC ORGANISMS
Ambient water-quality criteria for ammonia (salt water)-1989, 14:48074 (R;US)
Habitat requirements for Chesapeake Bay living resources. Chesapeake Bay Program Agreement Commitment Report, 14:47234 (R;US)
Utility of surface-floating Vhironomidae pupal exuviae in assessing the impact of PCBs on two stream communities. Technical report, 14:48036 (R;US)
AQUEOUS HUMOR
See EYES
AQUEOUS SOLUTIONS
Application of ESR technique and low-temperature radiation chemistry to determine the number of water molecules in a hydrate shell of dissolved substance, 14:47542 (RA;SU;In Russian)
AQUIFERS
Biodegradation of trichloroethylene and biomanipulation of aquifers. Technical report (Final), 14:48030 (R;US)
Fate and transport of petroleum released from leaking underground-storage tanks in areas of karst topography. Technical report, 14:46900 (R;US)
Use of analytical models to characterize contaminant exposures in aquifers with limited field data, 14:48020 (RA;US)
ARMATURES
High gain flux compression generator fabrication issues, 14:47768 (R;US)
ARMS CONTROL
Intermediate-range nuclear forces (INF) treaty: History of an illusion, 14:47320 (R;US)
Proliferation of chemical weapons: putting the genie back in the bottle. Study project, 14:47321 (R;US)
ARMY PERSONNEL
See MILITARY PERSONNEL
AROMATIC COMPOUNDS
See AROMATICS
AROMATICS
The effect of degree of aromaticity and alkyl substitution of polyaromatic hydrocarbons on instrumental response factors, 14:46836 (R;US)
ARRAY PROCESSORS
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Automating the multiprocessing environment, 14:48731 (R;US)
Design and implementation of a parallel computer for expert system applications, 14:48739 (BA;US)
Fault detection and reliability of the GASS (Geophysical Airborne Survey System) multiprocessor survey system, 14:48717 (R;US)
Initial operating capability for the hypercluster parallel-processing test bed, 14:48733 (R;US)
Laboratory for Computer Science progress report 24, July 1986-June 1987, 14:48716 (R;US)
Memory-reference characteristics of multiprocessor applications under MACH, 14:48713 (R;US)
Message passing kernel for the hypercluster parallel processing test bed, 14:48732 (R;US)
Parallel implementation of OPS5 on the Encore multiprocessor: Results and analysis, 14:48714 (R;US)
Parallel version of the Boyer-Moore prover. Technical report, 14:48712 (R;US)
ARSENIC
Boiling of geothermal waters: precipitation of base and precious metals, speciation of arsenic and antimony, and the role of gas phase metal transport, 14:47060 (RA;US)
Conventional weapons demilitarization: A health and environmental effects data base assessment: Methods for estimating multi-pathway exposures to environmental contaminants, Final report, Phase 2, 14:48155 (R;US)
Microbial dissolution of toxic metals from coal residues, 14:46839 (RA;US)
ARSENIC COMPOUNDS
Energy relaxation of light holes in $InAs_{.15}Sb_{.85}/InSb$ multiple quantum wells, 14:48523 (R;US)
ARSONIUM COMPOUNDS
See ARSENIC COMPOUNDS
ARTIFICIAL INTELLIGENCE
Laboratory for Computer Science progress report 24, July 1986-June 1987, 14:48716 (R;US)
ASBESTOS
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ASHES
Quench-induced nucleation of ash constituents during combustion of pulverized coal in a laboratory furnace, 14:46866 (BA;US)
ASPHALTS
Effect of volatility on dust flammability limits for coals, gilsonite, and polyethylene, 14:46842 (BA;US)

ASTEROIDS
Asteroid and comet flux in the neighborhood of the earth, 14:48208 (RA;US)
Collisions with ice-volatile objects: Geological implications, 14:48214 (RA;US)
Risk to civilization: A planetary science perspective, 14:48192 (RA;US)
ASTROPHYSICS
Nuclear astrophysics: from Big Bang to supernovae, 14:48178 (RA;AT;In German)
ATLANTIC OCEAN
[North Atlantic seasonal ecosystem model]: Foreign trip report, January 16–21, 1989, 14:48171 (R;US)
ATMOSPHERIC CIRCULATION
Feasibility report for a dispersion predictability model, 14:47957 (R;US)
ATMOSPHERIC EXPOSURE CHAMBERS
See EXPOSURE CHAMBERS
ATMOSPHERIC PRECIPITATIONS
1988 annual report of the Integrated Forest Study, 14:47933 (R;US)
ATOMIC BEAM DIFFRACTION
Measurement of angular differential cross sections at the SSL Atomic Scattering Facility, 14:48274 (RA;US)
ATOMIC BOMBS
See NUCLEAR WEAPONS
ATOMIC CLOUDS
See RADIOACTIVE CLOUDS
ATOMIC ENERGY
See NUCLEAR ENERGY
ATOMIC EXPLOSIONS
See NUCLEAR EXPLOSIONS
ATOMIC FLUORESCENCE SPECTROSCOPY
See FLUORESCENCE SPECTROSCOPY
ATOMIC IONS
Intermediate-velocity molecular and atomic ions in solids, 14:48528 (J;NL)
ATOMIC PHYSICS
HMI Section of Nuclear and Radiation Physics - annual report 1988, 14:48432 (R;DE;In German)
Physics Division annual review, April 1, 1988–March 31, 1989, 14:48426 (R;US)
ATOMIC SHELLS
See ELECTRONIC STRUCTURE
ATOMIC WEAPONS
See NUCLEAR WEAPONS
ATOMS
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AUGER EFFECT
[Auger effect symposium]: Foreign trip report, March 30, 1989–April 11, 1989, 14:48277 (R;US)
AURORAE
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AUSTRALIA
ANSTO strategic plan 1988-1993, 14:48709 (R;AU)
AUSTRALITES
See TEKTITES
AUTOMOBILE EFFICIENCY STANDARDS
See AUTOMOBILES
AUTOMOBILES
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AUTOMOTIVE FUELS
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AUXILIARY SYSTEMS
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AZO DYES
Carcinogenicity of azo dyes: Acid Black 52 and Yellow 3 in hamsters and rats. Volume 2. Technical report (Final), 14:48148 (R;US)

B

B CODES
An interactive program for constrained spline approximation of numerical data, 14:48735 (R;US)
BACKGROUND RADIATION
TMI [Three Mile Island] and the environment, 14:47172 (J;US)
BACTERIA
Depolymerization of low-rank coals by a unique microbial consortium, 14:46801 (RA;US)
BAG MODEL
Baryon charges of chiral bags, 14:48334 (RA;PL)
Metric bag model of hadrons, 14:48335 (RA;PL)
Present status of the bag model - a cursory review, 14:48399 (RA;PL)
BAGHOUSES
Baghouse efficiency on a multiple-hearth incinerator burning sewage sludge, 14:47950 (R;US)
BALLISTIC MISSILE DEFENSE
Draft Environmental Impact Statement. Peacekeeper Rail Garrison Program. Executive summary, 14:48081 (R;US)
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BARIUM COMPOUNDS
EPR spectra peculiarities of $Y_1Ba_2Cu_3O_{7-x}$ system, 14:48507 (RA;SU;In Russian)
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BARIUM ISOTOPES
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BARIUM OXIDES
A fermi liquid electric structure and the nature of the carriers in high-T_c cuprates: A photoemission study, 14:48531 (R;US)
Anomalous ion-channeling behavior across the superconducting transition in high-T_c materials, 14:48497 (R;US)
Effects of shock-modification on superconductivity in $Tl_2Ca_2Ba_2Cu_3O_y$ and $Bi_2CaSr_2Cu_2O_x$, 14:47404 (R;US)
Phonons and charge-transfer excitations in HTS superconductors, 14:48532 (R;US)
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BARK
Composting of surface peat, waste water sludge and bark, the properties and suitability of substietes for growing media for landscaping, 14:47038 (R;FI;In Finnish)
Use of surface peat in growing media for landscaping and public gardens in Northern Finland, 14:47039 (R;FI;In Finnish)
BARYON SPECTROSCOPY
Possible evidence for supersymmetry in hadron spectra, 14:48332 (RA;PL)

BARYONIUM
A consistent meson-theoretical model of the nucleon-antinucleon interaction, 14:48356 (R;DE;In German)
BASALT
Predicted reaction paths during the hydrothermal alteration of Columbia River basalt: A sensitivity analysis of variability in the composition of the mesostasis, 14:46960 (RA;US)
BATTERIES (ELECTRIC)
See ELECTRIC BATTERIES
BEAM BUNCHING
Impedances and instabilities of the AGS Booster, 14:47791 (R;US)
BEAM DYNAMICS
Beam diagnostics for the University of Washington superconducting booster, 14:47806 (R;US)
Microwave instability near transition energy, 14:47792 (R;US)
BEAM EMITTANCE
Minimized emittance growth with elliptical beam pipes in FEL [free-electron-laser], 14:47743 (R;US)
BEAM INJECTION
The Brookhaven accelerator test facility injection system, 14:47799 (R;US)
BEAM MONITORS
Beam loss monitor for the KEK PS-Booster synchrotron, 14:47811 (R;JP;In Japanese)
BEAM PERVEANCE
See BEAM EMITTANCE
BEAM TRANSPORT
BUCKSHOT simulations of electron beam transport in rectangular IFR [Ion Focused Regime] channels using ATA parameters, 14:47798 (R;US)
BEAM-FOIL SPECTROSCOPY
See ION SPECTROSCOPY
BEAM-GAS SPECTROSCOPY
See ION SPECTROSCOPY
BEAM-PLASMA SYSTEMS
Possibility of low-frequency electron wave in a beam-plasma system, 14:48587 (R;XA)
BEAUTY PARTICLES
B factory via conversion of 1 TeV electron beams into 1 TeV photon beams, 14:48324 (R;US)
B identification by topology with the SLD Detector, 14:48320 (R;US)
BENZENE
Benzene oxidation perturbed by NO_2 addition, 14:47634 (BA;US)
Calculation of the refractive index change in dissociating shocked benzene, 14:48524 (R;US)
Conventional weapons demilitarization: A health and environmental effects data base assessment: Methods for estimating multi-pathway exposures to environmental contaminants, Final report, Phase 2, 14:48155 (R;US)
Reactions of vinyl and phenyl radicals with ethyne, ethene and benzene, 14:47630 (BA;US)
The formation of polyhedral carbon ions in fuel-rich acetylene and benzene flames, 14:47571 (BA;US)
The influence of pressure and temperature on soot formation in premixed flames, 14:47572 (BA;US)
BENZOFURANS
Interactive chemistry of coal-petroleum processing: Quarterly report, March 16, 1989–June 15, 1989, 14:46898 (R;US)
BENZOPYRENE
Polycyclic aromatic hydrocarbons, particulates, and defense mechanisms (VKC-BAB-145). Final report, 14:47945 (R;US)
BENZYL RADICALS
The reactions of benzyl radicals with hydrogen atoms, oxygen atoms, and molecular oxygen using EI/REMPI mass spectrometry, 14:47632 (BA;US)
BERYLLIUM
A rate-dependent constitutive model for Be, 14:48525 (R;US)
Structural stability calculations for films and crystals, 14:47345 (RA;US)
BERYLLIUM 9 TARGET
Nuclear-target effects in J/psi production in anti p and π^- interactions, 14:48440 (J;NL)
BERYLLIUM MODERATORS
See BERYLLIUM
BETA RATIO
Beta limit of heliac plasmas, 14:48634 (RA;AU)
BF3 COUNTERS
Using ex-core neutron detectors to estimate fuel quantities in the reactor vessel lower head, 14:47175 (J;US)
BILLITONITES
See TEKTITES
BINARY ALLOY SYSTEMS
Empirical methods for predicting the phase diagrams of intermetallic alloys, 14:47342 (RA;US)
BINARY MIXTURES
Equations of state for hard-sphere fluids, 14:47759 (J;US)
BINARY STARS
Correlation between x-ray flux and rotational acceleration in Vela X-1. Final technical report, 14:48187 (R;US)
BINDERS
Extruded coal capsules for transport in fiber-water flow: Final technical report, 14:46845 (R;US)
BIOACCUMULATION
See BIOLOGICAL ACCUMULATION
BIOASSAY
Financial impact of implementing draft ANSI Standard N13.30, performance criteria for radiobioassay, 14:47148 (R;US)
Multiple endpoints for somatic mutations in humans provide complementary views for biodosimetry, genotoxicity, and health risks, 14:48094 (R;US)
BIOCONVERSION
A research plan for coal biogasification, 14:46799 (RA;US)
Introduction to workshop, 14:46795 (RA;US)
Recent progress in coal bioprocessing research in Europe, 14:46798 (RA;US)
Recent progress in coal bioprocessing research in the United States, 14:46797 (RA;US)
BIODEGRADATION
Modified purge-and-trap/gas-chromatography method for analysis of volatile halocarbons in microbiological degradation studies (journal version), 14:48031 (R;US)
BIOGAS
See METHANE
BIOLOGICAL ACCUMULATION
[Workshop on the Biospheric Model Validation Study (BIOMOVS)]: Foreign trip report, November 7–11, 1988, 14:47929 (R;US)
BIOLOGICAL MATERIALS
The application of synchrotron radiation to microprobe trace element analysis of biological samples, 14:47461 (R;US)
BIOLOGICAL TESTING
See BIOASSAY
BIOMASS
Biomass energy for Mississippi, 14:47030 (R;US)
[Collection of data on tropical forest inventories, Rome, Italy, March 20–25, 1989]: Foreign trip report, 14:47035 (R;US)
BIOTECHNOLOGY
Research and development in biotechnology-related industries in Japan (1989), 14:48092 (R;US)
BISMUTH 209 TARGET
Excitation and decay of giant multipole resonances in intermediate energy heavy ion reactions, 14:48457 (R;US)
BISMUTH 210
Detailed photonuclear cross-section calculations and astrophysical applications, 14:48484 (R;US)
BISMUTH OXIDES
A fermi liquid electric structure and the nature of the carriers in high-T_c cuprates: A photoemission study, 14:48531 (R;US)
Effects of shock-modification on superconductivity in $Tl_2Ca_2Ba_2Cu_3O_y$ and $Bi_2CaSr_2Cu_2O_x$, 14:47404 (R;US)
Infrared reflection and magnetic susceptibility of $Ba_{1-x}K_xBiO_{3-\delta}$, 14:47424 (RA;AT;In German)
Phonons and charge-transfer excitations in HTS superconductors, 14:48532 (R;US)
Preparation and characterization of single phase $Ba_{1-x}K_xBiO_3$, 14:47405 (R;US)

BITUMINOUS COAL
A study of depolymerization and crosslinking reactions in coal liquefaction: Final report, 14:46820 (R;US)
Coal fragmentation in a fluidized bed combustor, 14:46868 (BA;US)
Correlations for effects of coal type and pressure on tar yields from rapid devolatilization, 14:46853 (BA;US)
Laser pyrolysis of single coal particles in an electrodynamic balance, 14:46854 (BA;US)
Modeling the devolatilization behavior of high volatile bituminous coals, 14:46852 (BA;US)
Multiple heteroatom containing sulfur compounds in coals, 14:46832 (R;US)
On the products of the heterogeneous oxidation reaction at the surfaces of burning coal char particles, 14:46850 (BA;US)
Primary fragmentation of a coal in fluidized bed combustion, 14:46869 (BA;US)
Pulverized coal combustion: Fuel nitrogen mechanisms in the rich post-flame, 14:46873 (BA;US)
Pyrolysis-induced changes in the ring number composition of polycyclic aromatic compounds from a high volatile bituminous coal, 14:46855 (BA;US)
Slurry concentration and mesh size in the development of microbial coal desulfurization, 14:46807 (RA;US)
Spontaneous combustion in beds of coal particles, 14:46862 (BA;US)
The prediction of swirl burner pulverized coal flames, 14:46858 (BA;US)
The production and loss of char fines during fluidized bed combustion of a high volatile bituminous coal, 14:46867 (BA;US)

BLACK COAL
Studies on the water uptake capacity and pore structure of coal with a view to rock burst prevention, 14:46834 (R;DE;In German)

BLACK HOLES
On quantum effects near a black hole singularity, 14:48563 (R;XA)

BLACK LUNG DISEASE
See PNEUMOCONIOSES

BLACK SHALES
Devonian shale-specific computation methodology. Topical report, June 1988, 14:46906 (R;US)

BLADES (TURBINES)
See TURBINE BLADES

BLASTS
See EXPLOSIONS

BLOOD VESSELS
Platelet thrombosis in cardiac-valve prostheses, 14:48102 (R;US)

BNL
Future high energy heavy ion physics at Brookhaven, 14:47789 (J;NL)

BODY WAVES P (SEISMIC)
See SEISMIC P WAVES

BOILERS
Impacts of cleaning Texas lignite on boiler performance and economics: Final report, 14:46880 (R;US)
Report on on-line pulverized coal flow meters, 14:47079 (R;FI;In Finnish)

BOILING WATER COOLED AND MODERATED REACTOR
See BWR TYPE REACTORS

BOLTZMANN COLLISION INTEGRAL
See BOLTZMANN EQUATION

BOLTZMANN EQUATION
Kinetic boundary layer of the linearized Boltzmann equation at a partly absorbing sphere, 14:48260 (RA;AT;In German)
Solution of the non-linear Boltzmann equation for a homogeneous hard-sphere gas, 14:48263 (RA;AT;In German)

BOLTZMANN TRANSPORT EQUATION
See BOLTZMANN EQUATION

BOREHOLES
Borehole inspection system for large diameter holes, 14:47891 (RA;US)
Possible relation between sonic velocity measured at the edge of a large borehole and shear failure, 14:47895 (RA;US)

BORN-GREEN-YVON EQUATION
See BOLTZMANN EQUATION

BORON
An investigation of combustion of boron suspensions, 14:47706 (BA;US)
Chemical kinetic modeling and sensitivity analyses for boron assisted hydrocarbon combustion, 14:47622 (BA;US)
Ignition and combustion of metals in a carbon dioxide stream, 14:47683 (BA;US)

BORON ADDITIONS
Doped carbon electrodes for zinc-halogen batteries. Final report, February 1986-July 1986, 14:47205 (R;US)

BORON ALLOYS
Liquid Dynamic Campaction of Fe-Nd-B permanent magnets. Final report, 1 September 1984-31 December 1988, 14:47327 (R;US)

BORON COMPOUNDS
Different-ligand complexes of some d-metals with monovacant heteropolyanions, 14:47523 (RA;SU;In Russian)

BORON FLUORIDES
Low severity coal conversion by ionic hydrogenation: Progress report, May–July 1989, 14:46819 (R;US)

BORON NITRIDES
Effect of high temperature annealings on swelling and helium release in boron carbide irradiated with neutrons, 14:47393 (RA;SU;In Russian)
High-temperature materials compatibility testing of refractory crucible materials: TaC, Y_2O_3, Y_2O_3-coated MgO, and BN, 14:46930 (R;US)
Ultrafine microstructure composites prepared by chemical vapor deposition. Annual report, January-December 1988, 14:47408 (R;US)

BORON OXIDES
Static tensile and tensile creep testing of five ceramic fibers at elevated temperatures, 14:47397 (R;US)

BOROSILICATE GLASS
Effect of thermal and cyclic loads on silicon carbide yarn reinforced glass matrix composites: Final report, August 15, 1984–February 14, 1988, 14:47419 (R;US)
Thermodynamic and kinetic modeling of glass leaching in a waste package environment, 14:46962 (RA;US)

BOROSILICATES
See BOROSILICATE GLASS

BOSE-EINSTEIN GAS
Temperature correlators of the impenetrable Bose gas as an integrable system, 14:48559 (R;XA)

BOSONS
Divergences and involution-dependent constants, 14:48422 (J;US)
Non-standard bosonization techniques in conformal field theory, 14:48423 (J;US)

BOTTOM PARTICLES
See BEAUTY PARTICLES

BOTTOMONIUM
Heavy quarkonia in smoothed potential, 14:48346 (RA;SU;In Russian)

BOUNDARY LAYERS
Provenance of the K/T boundary layers, 14:48198 (RA;US)

BOUNDARY VALUE PROBLEMS
See BOUNDARY-VALUE PROBLEMS

BOUNDARY-VALUE PROBLEMS
Mixed singular linear elliptic equations, 14:48541 (R;XA)

BRAGG ANGLE
See BRAGG REFLECTION

BRAGG DIFFRACTION
See BRAGG REFLECTION

BRAGG LAW
See BRAGG REFLECTION

BRAGG REFLECTION
Neutron phase shift near a dynamic Bragg reflection, 14:48567 (RA;AT;In German)

BRAZIL
[Case studies examining energy policies and strategies for water resources development]: Foreign trip report, May 7–13, 1989, 14:48013 (R;US)

BREEDER REACTORS
Numerical simulation of a natural circulation decay heat removal experiment conducted at ETEC: Final report, 14:47100 (R;US)

BREMSSTRAHLUNG (MAGNETIC)
See SYNCHROTRON RADIATION

BROMINE
Orbital momentum distribution and binding energies for the complete valence shell of molecular bromine, 14:48252 (R;AU)

BROMINE 82
Preparation of radioactive labelled compounds Pt.1. ^{82}Br labelled organic bromine compounds, 14:47545 (R;FR;In French)
Preparation of radioactive labelled compounds. Pt. 2. ^{82}Br labelled organic bromine compounds by isotopic exchange, 14:47546 (R;FR;In French)

BROMINE BROMIDES
See BROMINE

BROMINE IODIDES
See IODINE BROMIDES

BROOKHAVEN AGS
Impedances and instabilities of the AGS Booster, 14:47791 (R;US)

BROOKHAVEN NATIONAL LABORATORY
See BNL

BROOKHAVEN RHIC
Conceptual design of the Relativistic Heavy Ion Collider [RHIC], 14:47782 (R;US)
Source options for RHIC, 14:47803 (R;US)

BROWN COAL
Coal combustion models for flame scaling, 14:46857 (BA;US)
Pulverized coal combustion: Fuel nitrogen mechanisms in the rich post-flame, 14:46873 (BA;US)

BROWNIAN MOVEMENT
Structure of a boundary layer in a system of Brownian particles, 14:48261 (RA;AT;In German)

BUCKLING
Fission-fusion adaptivity in finite elements for nonlinear dynamics of shells. Annual technical report, 1 October 1987-30 September 1988, 14:48461 (R;US)

BUILDING (CONSTRUCTING)
See CONSTRUCTION

BUILDING MATERIALS
Asbestos removal. January 1970-June 1989 (Citations from the NTIS data base). Report for January 1970-June 1989, 14:47958 (R;US)
Building Thermal Envelope Systems and Materials (BTESM) and research utilization/technology transfer progress report for DOE Office of Buildings and Community Systems: Monthly progress report, 14:47272 (R;US)

BUILDINGS
Analysis and technology transfer: Annual report 1988: Buildings and Community Systems, 14:47237 (R;US)
Outcome of 1988 work-stay at the University of Strathclyde in Glasgow, Scotland, 14:47267 (R;NL)
Study on large glass covered spaces. Section report of the research project 'Climate and energy', 14:47274 (R;NL;In (In Dutch))
Supplemental information for a notice of construction for the Fueled Clad Fabrication System, the Radioisotope Power Systems Facility, and the Fuel Assembly Area, 14:46985 (R;US)
The impact of performance standards on the uncertainty of the Pacific Northwest electric system: A final report on the hypersens analysis of CPAM [Conservation Policy Analysis Model], 14:47080 (R;US)

BUILDINGS (CONTAINMENT)
See CONTAINMENT BUILDINGS

BUNCHING (BEAM)
See BEAM BUNCHING

BURNERS
The prediction of swirl burner pulverized coal flames, 14:46858 (BA;US)

BURNUP
Actual experience in burnup determination of mixed oxide fuel, 14:47477 (RA;XA)
Burnup determination by the isotope correlation technique. Summary, 14:47094 (RA;XA)
Heavy isotope method for burnup determination of HFETR fuel elements, 14:47123 (RA;XA)
Non-destructive burnup determination of spent fuel in the framework of nuclear material safeguards, 14:47007 (RA;XA)
Non-destructive burnup determination: Experimental investigation on low burnup gadolinia fuel, 14:47089 (RA;XA)
Non-destructive measurements of water reactor fuel and evaluation of measurement techniques for improved assay accuracy, 14:47092 (RA;XA)
Passive neutron verification of WWER-440 spent fuel burnup, 14:47091 (RA;XA)
Techniques and equipment for determination of fuel burnup in water cooled reactors, 14:47090 (RA;XA)

BUTADIENE
Radiative properties of chain-agglomerated soot formed in hydrocarbon diffusion flames, 14:47647 (BA;US)

BUTANE
Autoignition chemistry of N-butane in a motored engine, 14:47021 (B;US)
Experimental simulation of engine knock by means of a preheated static combustion chamber, 14:47301 (BA;US)
Experiments on the sooting limits of aerodynamically-strained diffusion flames, 14:47570 (BA;US)
Measurements of nitrogen Q-branch foreign gas-broadening coefficients relevant to flames, 14:47464 (BA;US)

BUTANOLS
Temperature-dependent enantiospecificity of secondary alcohol dehydrogenase from Thermoanaerobacter ethanolicus, 14:47530 (J;US)

BUTENES
Kinetic study of 1-butene oxidation in a jet-stirred flow reactor, 14:47617 (BA;US)
Mechanism and rate constants for the reactions of hydrogen atoms with isobutene at high temperatures, 14:47629 (BA;US)

BUTYL ALCOHOLS
See BUTANOLS

BUTYLENES
See BUTENES

BUTYRIC ALCOHOLS
See BUTANOLS

BWR TYPE REACTORS
Analysis of the VENUS-3 experiments, 14:47105 (R;US)
Lessons learned from a review of post-accident sampling systems, high range effluent monitors and high concentration particulate iodine samplers, 14:47154 (BA;US)
Matrix database of EPRI experimental projects on small-break loss-of-coolant accidents: Final report, 14:47137 (R;US)
Operational data collection and analysis for nuclear plant life extension, 14:47088 (R;US)
Revised Severe Accident Research Program plan, FY 1990–1992, 14:47146 (R;US)
Thermal aging of some decommissioned reactor components and methodology for life prediction, 14:47084 (R;US)
Uncertainties in hydrogen combustion for nuclear reactor safety, 14:47151 (R;US)
[Reliability of reactor pressure components]: Foreign trip report, October 16–21, 1988, 14:47087 (R;US)

BY-PRODUCTS
Technologies and costs for the treatment and disposal of waste byproducts from water treatments for the removal of inorganic and radioactive contaminants (revised draft), September 1986, 14:48040 (R;US)

C

C CODES
Vectorization of nuclear codes 88-1. SRAC, CITATION, TWOTRAN-II, COREBN, CITATION-FBR, 14:47104 (R;JP;In Japanese)

C-1430 RESONANCES
See MESONS

CADMIUM
Cost supplement to the removal of cadmium from potable-water supplies (first draft), February 1987, 14:48042 (R;US)
Drinking-Water Criteria Document for Cadmium (final draft), December 1986. Final draft report, 14:48065 (R;US)
Evaluation of research on cadmium inhalation-exposure estimate and their significance for kidney and liver cadmium burden, 14:48149 (R;US)
Toxicological profile for cadmium. Final report, 14:48152 (R;US)

CADMIUM BROMIDES
$^{79,81}Br$, ^{127}I NQR study of Tl-containing inorganic compounds, 14:47502 (RA;SU;In Russian)

CADMIUM COMPOUNDS
Preparation and properties of La(2-x)AxCuO(4-y) where A = Pb,Cd. Technical report, 14:47387 (R;US)
Study of dynamic processes during phase transition in $ATiF_6$ center dot $6D_2O$ crystals, 14:47525 (RA;SU;In Russian)

CADMIUM SULFIDES
Cadmium sulfide mediated photoelectric effects in bilayer lipid membranes, 14:47540 (J;US)

CADMIUM TELLURIDES
Electron mobility in mercury cadmium telluride, 14:47442 (RA;US)
Two-photon absorption characterization. Interim performance report, 28 August-27 November 1988, 14:47409 (R;US)

CALCITE
Electron spin resonance of radiation-induced defects in calcite, 14:47428 (RA;AT;In German)
Modeling mass transfer reaction rates: Calcite precipitation and CO_2 outgassing in a Karst steam, 14:47064 (RA;US)
Radio-, Lyo- and Triboluminesence in $CaCO_3$ and NaCl, 14:47474 (RA;AT;In German)
Theory of calcite equation of state, 14:47445 (R;US)

CALCIUM
Advanced calcium-thionyl chloride high-power battery. Final report, 23 December 1987-22 December 1988, 14:47204 (R;IL)
Measurements of gamma-ray production nuclear data of calcium and chromium, 14:48447 (R;JP;In Japanese)
Promotion of char oxidation by inorganic constituents, 14:46849 (BA;US)

CALCIUM 45
Investigation of radiofrequency/microwave effects upon the central nervous system. Final report, 14:48157 (R;US)

CALCIUM 51
Study of ^{51}Ca via three-neutron transfer, 14:48446 (R;AU)

CALCIUM COMPOUNDS
Increased SO_2 removal with the addition of alkali metals and chromium to calcium-based sorbents, 14:46876 (BA;US)

CALCIUM IONS
Application of the generalized newton-raphson method to the singly-ionized calcium line formation problem in model stellar atmospheres. Doctoral thesis, 14:48220 (R;US)

CALCIUM OXIDES
A fermi liquid electric structure and the nature of the carriers in high-T_c cuprates: A photoemission study, 14:48531 (R;US)
Effects of shock-modification on superconductivity in $Tl_2Ca_2Ba_2Cu_3O_y$ and $Bi_2CaSr_2Cu_2O_x$, 14:47404 (R;US)

CALCULATIONS (1-DIMENSIONAL)
See ONE-DIMENSIONAL CALCULATIONS

CALIBRATION STANDARDS
Computerized procedure for preparation of secondary standards, 14:47472 (R;US)

CALIFORNIA
Health-risk assessment of trichlorofluoromethane in California drinking water, 14:48150 (R;US)
Short-term trends and spatial variability in precipitation chemistry in the South Coast Air Basin. Final report, 14:47934 (R;US)
Southern California Air Quality Study: Peroxyacetyl nitrate (PAN) measurements. Final report, 14:47941 (R;US)

CALIFORNIUM COMPOUNDS
Studies on rapid ion-exchange separation of the transplutonium elements with mineral acid-methanol mixed media, 14:47553 (R;JP)

CALORIMETERS
An automated flow calorimeter for heat capacity and enthalpy measurements, 14:47851 (J;US)
High resolution x-ray spectroscopy using germanium microcalorimeters, 14:47850 (R;US)
Scintillating fiber ribbon — tungsten calorimeter, 14:47807 (R;US)

CALORIMETERS (PARTICLE)
See SHOWER COUNTERS

CANADA
Economic pre-feasibility study: large-scale methanol fuel production from surplus Canadian forest biomass. Part 1, summary report, 14:47026 (R;CA)
Free trade and energy, 14:47212 (R;CA;In English and French)
Free trade on the prairies. The implications of the Canada-U.S. trade pact for the three prairie provinces, 14:47251 (R;CA)
Sudbury Structure (Ontario, Canada) and Vredefort Structure (South Africa): A comparison, 14:48195 (RA;US)

CANADIAN ORGANIZATIONS
Contract R&D technically administered by the Energy Research Laboratories. FY 1985/86, 14:47239 (R;CA)
Energy, Mines and Resources Canada, 1987-88 estimates. Part 3, expenditure, 14:47211 (R;CA;In English and French)
Northern Pipeline Agency Canada, 1989-90 estimates. Part 3, expenditure plan, 14:46914 (R;CA;In English and French)

CANALS (WATERWAYS)
See INLAND WATERWAYS

CANCER
See NEOPLASMS

CANDIDA
Biological solubilization of coal in aqueous and nonaqueous media, 14:46806 (RA;US)
Comparison of alkali and microbial solubilization of oxidized, low-rank coal, 14:46803 (RA;US)

CANINES
See DOGS

CANONICAL EQUATIONS
See DIFFERENTIAL EQUATIONS

CANONICAL TRANSFORMATIONS
Microcanonical Monte Carlo, 14:48579 (BA;US)
The canonical structure of the manifestly supersymmetric string, 14:48384 (J;US)

CAPACITORS
Lifetime testing of commercially available 3.0 μf, 100 kV pulsed-power capacitors, 14:48690 (R;US)

CARBAZOLES
Interactive chemistry of coal-petroleum processing: Quarterly report, March 16, 1989–June 15, 1989, 14:46898 (R;US)

CARBINOL
See METHANOL

CARBON
Carbon in detonations, 14:47856 (R;US)
New interpretation of rupture strength using the potential drop technique, 14:47383 (BA;US)
Weak homogeneous burning in front of a carbon surface, 14:46848 (BA;US)

CARBON 12 REACTIONS
Measurements of fusion cross section for $^{12}C + ^{63,65}$ Cu systems, 14:48448 (R;BR;In Portuguese)

CARBON 14
Leaching of ^{14}C and ^{36}Cl from irradiated French graphite, 14:46978 (R;US)
Studies of environmental radioactivity in Cumbria. Pt. 13. Measurements of carbon-14 in tree rings from trees growing in the Sellafield area, 14:47959 (R;GB)

CARBON DIOXIDE
Measurements of absolute rate coefficients for the reactions of CN radicals with H_2O, H_2, and CO_2 in the temperature range 295 K $\leq$ T $\leq$ 1027 K, 14:47637 (BA;US)

Modeling mass transfer reaction rates: Calcite precipitation and CO_2 outgassing in a Karst steam, 14:47064 (RA;US)
Photodynamics of a nickel hydrocorphinoid model of F_{430}, 14:47022 (J;US)
[Analysis of vegetation responses to changes in the global environment]: Foreign trip report, March 29, 1989–April 7, 1989, 14:47932 (R;US)
[Responses of coniferous species to atmospheric CO_2 enrichment]: Foreign trip report, September 19–30, 1988, 14:47928 (R;US)

CARBON IONS
The formation of polyhedral carbon ions in fuel-rich acetylene and benzene flames, 14:47571 (BA;US)

CARBON MONOXIDE
Catalogic hydrogenation of carbon monoxide: Final progress report, September 15, 1988–September 14, 1989, 14:47024 (R;US)
Combustion efficiency, radiation, CO and soot yield from a variety of gaseous, liquid, and solid fueled buoyant diffusion flames, 14:46902 (BA;US)
Electronic structure calculations for low coverage adlayers, 14:46794 (RA;US)
Formation of NO_x and burnoff of CO during thermal quenching of the products from combustion in a thermally stabilized burner, 14:47642 (BA;US)
Structures of wet CO flames with full and reduced kinetic mechanisms, 14:47663 (BA;US)

CARBONACEOUS MATERIALS
Reaction order for low temperature oxidation of carbons, 14:47559 (BA;US)

CARBONATE ROCKS
Fate and transport of petroleum released from leaking underground-storage tanks in areas of karst topography. Technical report, 14:46900 (R;US)

CARBORANES
Spectroscopic studies of cesium, strontium, and cerium (3) ion complexing with cobalt chlorinated dicarbollide (CCD) and hexapolyethylene glycol (HPEG) in nitrobenzene, 14:47517 (RA;SU;In Russian)

CARCINOGENS
[Short-term assays for detecting environmental mutagens, carcinogens, and teratogens]: Foreign trip report, February 4–28, 1989, 14:48145 (R;US)

CARDIAC PACEMAKERS
Troubles of cardiac pacemakers due to irradiation at a linear accelerator, 14:48125 (RA;AT;In German)

CASCADES (NUCLEAR)
See NUCLEAR CASCADES

CASIMIR EFFECT
Casimir force between two Aharonov-Bohm selenoids, 14:48393 (R;XA)

CASINGS
See COVERINGS

CATALYSIS
Catalysis by design: A coordinated approach to catalyst research and development, 14:47294 (R;US)
Semiempirical molecular orbital modeling of catalytic reactions including promoter effects, 14:47346 (RA;US)

CATALYSTS
Catalysis by design: A coordinated approach to catalyst research and development, 14:47294 (R;US)
Coal liquefaction process solvent characterization and evaluation: Technical progress report, July 1–September 30, 1988, 14:46818 (R;US)
Studies of supported hydrodesulfurization catalysts: Progress report for period January 1, 1989–December 31, 1989, 14:47484 (R;US)

CATHODES
Cathode spot phenomena in continuous and pulsed vacuum arcs, 14:48270 (RA;AU)
Gas evolution and bubble formation on electrodes, 14:47017 (R;DE;In German)
Suppression of volume breakdown in vacuum with coatings, 14:47448 (R;US)

CAVITIES
CORNUCOPIA cavity pressure measurement, 14:47900 (RA;US)
Chemical considerations and containment, 14:47901 (RA;US)
Development of centrifuge modeling for evaluating the mechanisms of collapse of underground opening, 14:47911 (RA;US)
Effects of late time creep and cavity depressurization on the residual stress field, 14:47879 (RA;US)
Fickian filtering of cavity gases rising through a fractured permeable overburden, 14:47905 (RA;US)
Fluid dynamics of a pressure measuring system for underground explosive tests, 14:47899 (RA;US)
Junior Jade events - An investigation of decoupling phenomenology, 14:47873 (RA;US)
Photogrammetric method for determining sink volumes at the Nevada Test Site, 14:47913 (RA;US)
Reaction kinetics and hydrogen generation, 14:47902 (RA;US)
Trends in cavity collapse data, 14:47912 (RA;US)

CAVITY RESONATORS
Gyroklystron device having multi-slot bunching cavities, 14:47772 (P;US)

CELL GROWTH (ANIMAL)
See ANIMAL CELLS

CELLOBIOSE
Microbial solubilization of peat for production of synthetic fuels, 14:46805 (RA;US)

CELLS (ANIMAL)
See ANIMAL CELLS

CELLS (BACTERIAL)
See BACTERIA

CELLS (ELECTROLYTIC)
See ELECTROLYTIC CELLS

CELLULASE
Microbial solubilization of peat for production of synthetic fuels, 14:46805 (RA;US)

CELLULASES
See CELLULASE

CENTRAL NERVOUS SYSTEM
Investigation of radiofrequency/microwave effects upon the central nervous system. Final report, 14:48157 (R;US)

CENTRIFUGES
Development for centrifuge modeling of buried explosions, 14:47910 (RA;US)

CERAMICS
High-temperature ceramic superconductors. Report for 1 January-31 March 1989, 14:47713 (R;US)
Nickel oxide, ceramic-insulated, high-temperature coating, 14:47407 (P;US)
Polishing methods for metallic and ceramic transmission electron microscopy specimens: Revision 1, 14:47329 (R;US)
Study of the corrosion of ceramic materials in a simulated advanced glass melter flue-gas environment. Topical report, June 1987-May 1988, 14:47403 (R;US)
[Mechanical testing of advanced ceramics]: Foreign trip report, April 11–15, 1988, 14:47761 (R;US)
[Program for measurements and models of grain boundary and surface energies of metals and ceramics]: Foreign trip report, March 7–17, 1988, 14:47373 (R;US)
[Structure-property relationships in surface-modified ceramics]: Foreign trip report, April 11–24, 1988, 14:47399 (R;US)
[Technologies for future industries]: Foreign trip report, March 18–31, 1988, 14:47398 (R;US)
[US-Japan workshop on small specimen test techniques, Tokyo, Japan, and visits to Sapporo, Fukuoka, and Nagoya, Japan, February 17–25, 1988]: Foreign trip report, 14:47372 (R;US)

CERIUM 142
Mixed-symmetry in the vibrational nucleus ^{142}Ce, 14:48450 (R;AU)

CERIUM ALLOYS
Unstable magnetic order in intermetallic compounds, 14:47356 (RA;AT;In German)

CERIUM COMPLEXES
Laser spectroscopy of rare earth (3) ion complexes with inorganic anions in nonaqueous solutions, 14:47507 (RA;SU;In Russian)

Spectroscopic studies of cesium, strontium, and cerium (3) ion complexing with cobalt chlorinated dicarbollide (CCD) and hexapolyethylene glycol (HPEG) in nitrobenzene, 14:47517 (RA;SU;In Russian)

CERIUM COMPOUNDS
Static and dynamic characteristics of cerium ion in ethylsulfates under high pressure, 14:47487 (RA;SU;In Russian)
Superconductivity and magnetic scattering in the $Nd_{2-x}Ce_xCuO_{4-\delta}$, 14:48535 (R;US)

CERN II SYNCHROTRON
See CERN SPS SYNCHROTRON

CERN SPS SYNCHROTRON
[Lead beams at CERN SPS synchrotron]: Foreign trip report, January 30, 1989–February 3, 1989, 14:47788 (R;US)
[Lead beams at CERN]: Foreign trip report, April 14, 1988–April 29, 1988, 14:47797 (R;US)
[Sulfur 32 beams on the CERN SPS synchrotron]: Foreign trip report, November 1–2, 1988, 14:47787 (R;US)

CESIUM 134
Measurement of radioactivity from Chernobyl in population groups in Scotland, 14:47991 (R;GB)
Uptake of radiocaesium by upland herbaceous vegetation in relation to soil type, 14:47988 (R;GB)

CESIUM 137
Measurement of radioactivity from Chernobyl in population groups in Scotland, 14:47991 (R;GB)
Radiocesium binding substances in livestock production, 14:48122 (R;DE;In German)

CESIUM BROMIDES
$^{79,81}Br$ NQR study of phase transition in $CsHg_2Br_5$, 14:47512 (RA;SU;In Russian)
$^{79,81}Br$ NQR study of the compounds in the system $CsBr-ZnBr_2$, 14:47513 (RA;SU;In Russian)

CESIUM COMPLEXES
Spectroscopic studies of cesium, strontium, and cerium (3) ion complexing with cobalt chlorinated dicarbollide (CCD) and hexapolyethylene glycol (HPEG) in nitrobenzene, 14:47517 (RA;SU;In Russian)

CHALKS
See LIMESTONE

CHARGE EXCHANGE
Low-energy atomic collisions. Final scientific report, 1 June-30 September 1980, 14:48243 (R;US)

CHARGED PARTICLES
On averaged force acting on a particle in H.F electromagnetic field, 14:48588 (R;XA)
Space particle environment. Technical report, 14:48237 (R;US)

CHARGED-PARTICLE ACTIVATION
See CHARGED PARTICLES

CHARM PARTICLES
Sensitivity of high-energy muon flux from atmosphere to parameters of hadronic charm production, 14:48239 (RA;SU;In Russian)

CHARS
Combustion of coal char agglomerates in a combustion gas environment, 14:46851 (BA;US)
Micropore diffusion in coal chars under reactive conditions: Quarterly technical progress report, 15 December 1988–15 March 1989, 14:46822 (R;US)
Overall kinetic parameters for combustion of a highly nonspherical carbon char, 14:47557 (BA;US)
Reaction order for low temperature oxidation of carbons, 14:47559 (BA;US)
The evolution of porosity during the combustion of char: The fractal approach and the statistic description, 14:47558 (BA;US)

CHEMICAL EFFLUENTS
An evaluation of the use of a combination of ozone, ultraviolet radiation, and hydrogen peroxide to remove chlorinated hydrocarbons from groundwater at the Department of Energy Kansas City Plant: Fiscal year 1988, annual report, 14:48026 (R;US)
Treatment and disposal options for a heavy metals waste containing soluble Technetium-99, 14:46968 (R;US)

CHEMICAL EXPLOSIVES
Application of crystal-lattice disintegration criteria to compute minimum shock-induced reactive conditions in solid explosives and inert materials. Final technical report, August 1987-August 1988, 14:47853 (R;US)
Carbon in detonations, 14:47856 (R;US)
Conventional weapons demilitarization: A health and environmental effects data base assessment: Methods for estimating multi-pathway exposures to environmental contaminants, Final report, Phase 2, 14:48155 (R;US)
Hazards of explosives dusts: Internal report No. 4784, 14:47854 (R;US)
Lagrangian analysis of MIV [Magnetic Impulse-Velocity] gauge experiments on PBX 9502 using the mass-displacement moment function, 14:47858 (R;US)
Model calculations and experimental measurements of the response of HMX porous beds to deflagration and shock, 14:47865 (R;US)
Powder morphology effects in the ignition of titanium-based pyrotechnics, 14:47860 (R;US)
Remedial investigation of the High Explosives Burn Pit facility, Building 829 complex, Lawrence Livermore National Laboratory site 300, 14:47862 (R;US)
Sensitivity relationships in energetic materials, 14:47859 (R;US)
Shock initiation of LX-17 as a function of its initial temperature, 14:47864 (R;US)
VISAR wave profile measurements in supra-compressed HE, 14:47863 (R;US)

CHEMICAL INDUSTRY
Best demonstrated available technology (BDAT) background document for K103 and K104. Final report, 14:47290 (R;US)
Evaluation of dustiness test methods and recommendations for improved dust control at Heubach Inc., Newark, New Jersey. Study report, 14:47942 (R;US)
Fuel cells application in the industrial sector: Task 15, Final report, 14:47284 (R;US)
Superfund Record of Decision (EPA Region 3): Drake Chemical Site, Lock Haven, Pennsylvania (third remedial action), September 1988. Final report, 14:48079 (R;US)
Superfund Record of Decision (EPA Region 4): Celanese Fibers Operations, Shelby, North Sarolina (first remedial action), March 1988, 14:48078 (R;US)
Superfund Record of Decision (EPA Region 5): Velsicol Chemical Corporation, Marshall, Illinois (first remedial action), September 1988. Final report, 14:48076 (R;US)

CHEMICAL MUTAGENS
See MUTAGENS

CHEMICAL REACTION KINETICS
Understanding complex chemical kinetics with computational singular perturbation, 14:47623 (BA;US)

CHEMICAL REACTIONS
Complex temporal and spatial patterns in nonequilibrium systems: Progress report, December 1, 1988–November 30, 1989, 14:48498 (R;US)
Shock-induced reaction in several liquids, 14:48519 (R;US)

CHEMICAL REACTORS
Irreversibility reduction of low-temperature, combustion heat sources, 14:47285 (R;US)

CHEMICAL WARFARE
Proliferation of chemical weapons: putting the genie back in the bottle. Study project, 14:47321 (R;US)

CHEMICAL WARFARE AGENTS
Disposing of the US chemical weapons stockpile. An approaching reality, 14:48156 (J;US)

CHEMICAL WASTES
Best demonstrated available technology (BDAT) background document for K103 and K104. Final report, 14:47290 (R;US)

CHEMISTRY
Chemistry Division annual progress report for period ending March 31, 1989, 14:47460 (R;US)
Summaries of FY 1989 research in the chemical sciences, 14:47238 (R;US)

CHERNOBYLSK-4 REACTOR
Comparison of hot particles in the Chernobyl fallout and in the nuclear weapons tests fallout, 14:47960 (RA;AT;In German)
Emergency preparedness lessons from Chernobyl, 14:47159 (BA;US)
Environmental impacts of Chernobyl reactor accident in German Democratic Republic, 14:47130 (R;FR;In French)
Environmental radioactivity and water supply. Pt. 3. The contamination of surface waters in Germany after the Chernobyl reactor accident, 14:47127 (R;FR;In French)
Modelling of radioactive fallout in the vicinity of Chernobyl nuclear power plant accident, 14:47126 (R;FR;In French)
Radiological consequences of the Chernobyl accident in the Soviet union and measures taken to mitigate their impact, 14:47128 (R;FR;In French)
Radiological effects of Chernobyl reactor accident on the lakes of Southern Bavaria, 14:47125 (R;FR;In French)
Thyroid dose from ^{131} iodine of the population in Poland following the Chernobyl accident, 14:47129 (R;FR;In French)
Vertical distribution of the Chernobyl fallout in snow profiles, 14:47992 (RA;AT;In German)

CHESAPEAKE BAY
Chesapeake bay basinwide toxics reduction strategy: an agreement commitment report from the Chesapeake Executive Council. Final report, 14:48052 (R;US)
Habitat requirements for Chesapeake Bay living resources. Chesapeake Bay Program Agreement Commitment Report, 14:47234 (R;US)
Understanding the estuary: Advances in Chesapeake Bay research, 14:48050 (R;US)

CHI RESONANCES
See MESONS

CHI-2800 RESONANCES
See MESONS

CHI-3455 RESONANCES
See MESONS

CHINA
New approach to the origin of the tektite in China, 14:48215 (RA;US)

CHIRAL
See ENANTIOMORPHS

CHIRAL SYMMETRY
Status of the $\Delta I = 1/2$ rule in Kaon decay, 14:48381 (J;US)

CHLOR-ALKALI INDUSTRY
See CHEMICAL INDUSTRY
CHLORINE

CHLORINATED ALIPHATIC HYDROCARBONS
An experimental investigation of the incineration and incinerability of chlorinated alkane droplets, 14:47709 (BA;US)
Biodegradation of trichloroethylene and biomanipulation of aquifers. Technical report (Final), 14:48030 (R;US)
Drinking-Water Criteria Document for polychlorinated biphenyls (PCBs) (final), April 1988, 14:48067 (R;US)

CHLORINATED AROMATIC HYDROCARBONS
In situ immobilization of PCBs at Pepper's Steel and Alloys site establishes a precedent as permanent remedy for nonvolatile organics, 14:47979 (RA;US)
Resonantly enhanced multiphoton ionization for the trace detection of chlorinated aromatics, 14:47463 (BA;US)
Superfund Record of Decision (EPA Region 9): MGM Brakes site, Cloverdale, California (first remedial action), September 1988. Final report, 14:48054 (R;US)
Superfund Record of Decision: (EPR Region 6): Curley Pit Site, ground-water operable unit, Crittenden County, Arkansas (second remedial action), September 1988. Final report, 14:48055 (R;US)
Utility of surface-floating Vhironomidae pupal exuviae in assessing the impact of PCBs on two stream communities. Technical report, 14:48036 (R;US)

CHLORINE
Orbital momentum distribution and binding energies for the complete valence shell of molecular chlorine by electron momentum spectroscopy, 14:48249 (R;AU)

CHLORINE 36
Leaching of ^{14}C and ^{36}Cl from irradiated French graphite, 14:46978 (R;US)

CHLORINE CHLORIDES
See CHLORINE

CHLORITE MINERALS
Chlorite solubility between 200°C and 350°C: An experimental and theoretical modeling study, 14:47066 (RA;US)

CHOLINESTERASE
Isolating a cell maximally secreting acetylcholinesterase. Annual report, 31 January 1984-30 January 1985, 14:48084 (R;US)

CHROMIUM
Increased SO_2 removal with the addition of alkali metals and chromium to calcium-based sorbents, 14:46876 (BA;US)
Measurements of gamma-ray production nuclear data of calcium and chromium, 14:48447 (R;JP;In Japanese)
Microbial dissolution of toxic metals from coal residues, 14:46839 (RA;US)

CHROMIUM ALLOYS
Tensile behavior of helium-implanted and neutron-irradiated V-15 Cr-5 Ti, 14:48697 (J;US)

CHROMIUM OXIDES
A review on the effects of microalloying, surface treatment and oxidation conditions on the formation and breakdown of protective oxide scales on fossil energy materials, 14:46824 (R;US)
Breakdown of chromium oxide scales in sulfur-containing environments at elevated temperatures, 14:47385 (J;US)
Rutherford-backscattering study of high-temperature oxidation of Y-implanted Fe-24Cr, 14:47384 (J;US)
Transport properties of thermally grown Cr_2O_3, 14:47388 (R;US)

CHROMIUM STEELS
Peculiarities of surface erosion of Kh13 steel during hydrogen plasma exposure, 14:47368 (RA;SU;In Russian)
Rutherford-backscattering study of high-temperature oxidation of Y-implanted Fe-24Cr, 14:47384 (J;US)

CHROMIUM-NICKEL STEELS
Breakdown of chromium oxide scales in sulfur-containing environments at elevated temperatures, 14:47385 (J;US)
Formation of strain martensite in 07Kh18N9 and 03Kh16N9M2 steels and radiation-induced structure-phase transformations, 14:47364 (RA;SU;In Russian)

CHROMODYNAMICS
See QUANTUM CHROMODYNAMICS

CISTRONS
See GENES

CITIES
See URBAN AREAS

CLASSICAL MECHANICS
The classical harmonic oscillator on Galois and P-adic fields, 14:48425 (J;US)
Theory of singular Lagrangians, 14:48543 (R;XA)

CLAYS
Characterization of sorbed oil components on clays and quartz grains in oil sand. A contribution to the wettability of reservoir rocks in petroleum deposits, 14:46920 (R;DE;In German)

CLEAN WATER ACT
Ambient water-quality criteria for ammonia (salt water)-1989, 14:48074 (R;US)
Guidelines and requirements for applying for grants from the Indian set-aside program, 14:48073 (R;US)
Needs survey report to Congress, 1988: assessment of needed publicly owned waste-water treatment facilities in the United States, 14:48058 (R;US)
Response of the US EPA (Environmental Protection Agency) region 5 states to the nonpoint source reporting requirements of the 1987 Clean Water Act amendments. Technical report, 14:48056 (R;US)
Sludge Incineration Modeling (SIM) system user's guide. Draft report, 14:48051 (R;US)

CLIMATES
Contribution of deforestation to atmospheric CO_2 and reforestation as an option to control CO_2, 14:47923 (R;US)

[Responses of coniferous species to atmospheric CO_2 enrichment]: Foreign trip report, September 19–30, 1988, 14:47928 (R;US)
[SCOPE workshop on Landscape boundaries: Consequences for biotic diversity and ecological flows]: Foreign trip report, December 12–15, 1988, 14:47976 (R;US)

CLINCH RIVER
Characterization of hazardous spill transport in the Clinch River, Tennessee, 14:48019 (RA;US)

CLOSTRIDIUM
Biological conversion of synthesis gas into liquid fuels, 14:46800 (RA;US)

CLOSURES
Computed and measured responses of a thick-walled hollow cylinder of salt subjected to both homogeneous and inhomogeneous loading, 14:46983 (R;US)

CLOTHES DRYERS
Advanced-technology gas-fired commercial clothes dryer. Final report, April 1985-December 1988, 14:46907 (R;US)

CLOUDS
Fog, cloud, and dew chemistry. Final report, 14:47940 (R;US)

CLUSTERS (GALAXY)
See GALAXY CLUSTERS

CLUSTERS (ION)
See ION PAIRS

CLUSTERS (STAR)
See STAR CLUSTERS

COAL

Bioconversion
A research plan for coal biogasification, 14:46799 (RA;US)
Introduction to workshop, 14:46795 (RA;US)
Introductory remarks, 14:46796 (RA;US)
Recent progress in coal bioprocessing research in Europe, 14:46798 (RA;US)
Recent progress in coal bioprocessing research in the United States, 14:46797 (RA;US)

Biodegradation
A comparison between Thiobacillus ferrooxidans and biological by-products in the desulfurization of coal fines in flotation, 14:46812 (RA;US)
Biological solubilization of coal in aqueous and nonaqueous media, 14:46806 (RA;US)
Desulfurization of coal by bacterial means, 14:46810 (RA;US)
Microbial desulfurization of coal: A feasible process?, 14:46811 (RA;US)
Partial degradation of untreated, hard coal by microorganisms, 14:46802 (RA;US)
Pyrite decomposition and structural alteration of hard coal due to microbe-assisted pyrite removal, 14:46813 (RA;US)

Carcinogens
Polycyclic aromatic hydrocarbons, particulates, and defense mechanisms (VKC-BAB-145). Final report, 14:47945 (R;US)

Chemical Composition
Coal liquefaction process solvent characterization and evaluation: Technical progress report, July 1–September 30, 1988, 14:46818 (R;US)

Cleaning
Advanced technology for ancillary coal cleaning operations: Final report, 14:46790 (R;US)

Combustion
Coal-fueled diesel: Technology development: Final report, 14:47305 (R;US)
Coal-fueled diesels, 14:47312 (BA;US)
Cooper-bessemer coal-fueled engine system, 14:47313 (BA;US)
Development of slag-tap combustor for high intensity pulverized coal combustion, 14:46860 (BA;US)
Proceedings of the sixth annual coal-fueled heat engines and gas stream cleanup systems contractors review meeting, 14:46879 (R;US)
The use of nonsymmetrical jets for the stabilization of low grade coal flames, 14:46861 (BA;US)

Combustion Control
Stationary combustion: The environmental leitmotiv, 14:46846 (BA;US)

Combustion Kinetics
Application of FT-IR emission/transmission (E/T) spectroscopy to study coal combustion phenomena, 14:46863 (BA;US)
Ignition of coal particles, 14:46885 (J;US)
Increased SO_2 removal with the addition of alkali metals and chromium to calcium-based sorbents, 14:46876 (BA;US)

Combustion Products
Estimating air-toxics emission from coal and oil combustion sources. Final report, 14:47953 (R;US)

Coprocessing
Interactive chemistry of coal-petroleum processing: Quarterly report, March 16, 1989–June 15, 1989, 14:46898 (R;US)

Corrosive Effects
Erosion-corrosion of materials by coal-water slurries, 14:46827 (BA;US)

Desulfurization
A comparison between Thiobacillus ferrooxidans and biological by-products in the desulfurization of coal fines in flotation, 14:46812 (RA;US)
Desulfurization of coal by bacterial means, 14:46810 (RA;US)
Microbial degradation of organosulfur compounds: Implications for the microbial desulfurization of coal, 14:46809 (RA;US)
Microbial desulfurization of coal: A feasible process?, 14:46811 (RA;US)
Pyrite decomposition and structural alteration of hard coal due to microbe-assisted pyrite removal, 14:46813 (RA;US)

Devolatilization
Particle rotation in coal combustion: Statistical, experimental and theoretical studies, 14:46856 (BA;US)
Steam conditioning of coal for synfuels production: Final report, 14:46817 (R;US)

Diffusion
Micropore diffusion in coal chars under reactive conditions: Quarterly technical progress report, 15 December 1988–15 March 1989, 14:46822 (R;US)

Flotation
A comparison between Thiobacillus ferrooxidans and biological by-products in the desulfurization of coal fines in flotation, 14:46812 (RA;US)

Fluidized-Bed Combustion
The reduction of NO_x emissions from a fluidized bed combustor by staged combustion combined with ammonia addition, 14:46875 (BA;US)
The role of peripheral percolation in detachment of fines from burning carbon particles, 14:46847 (BA;US)
[Coal conversion, renewable energy and energy efficiency in India]: Foreign trip report, October 31, 1988–December 8, 1988, 14:46882 (R;US)
[Fluidized bed combustion of high-ash Indian coals]: Foreign trip report, January 5, 1988–March 16, 1988, 14:46881 (R;US)

Hydrogenation
Low severity coal conversion by ionic hydrogenation: Progress report, May–July 1989, 14:46819 (R;US)
Solid phase coal liquefaction by mild hydrogenation. Solid NMR studies, 14:46837 (R;FR;In French)

Nmr Spectra
Solid phase coal liquefaction by mild hydrogenation. Solid NMR studies, 14:46837 (R;FR;In French)

Quantitative Chemical Analysis
Chemical characterisation of coal and coal products, 14:46835 (R;XE)

Research Programs
[Pittsburgh Energy Technology Center] quarterly technical progress report for the period ending June 30, 1988, 14:46791 (R;US)

Staged Combustion
Advanced NO_x reduction processes using -NH and -CN compounds in conjunction with staged air addition, 14:46874 (BA;US)
Reduction of NO_x emissions in a swirled coal flame by particle injection into the internal recirculation zone, 14:46872 (BA;US)
The reduction of NO_x emissions from a fluidized bed combustor by staged combustion combined with ammonia addition, 14:46875 (BA;US)

Transport
Extruded coal capsules for transport in fiber-water flow: Final technical report, 14:46845 (R;US)

COAL DEPOSITS
Three-dimensional hydraulic fracture model development for application to and understanding of coal-bed methane-stimulation treatments. Final report, July 1, 1984-December 16, 1988, 14:46913 (R;US)

COAL EXTRACTS
Comparison of alkali and microbial solubilization of oxidized, low-rank coal, 14:46803 (RA;US)

COAL FINES
Combustion characteristics of dry-coal-powder-fueled adiabatic diesel engine, 14:46884 (BA;US)
Effect of volatility on dust flammability limits for coals, gilsonite, and polyethylene, 14:46842 (BA;US)
Progress on the investigation of coal-water-slurry fuel combustion in a medium-speed diesel engine, 14:47314 (BA;US)
The production and loss of char fines during fluidized bed combustion of a high volatile bituminous coal, 14:46867 (BA;US)
The role of peripheral percolation in detachment of fines from burning carbon particles, 14:46847 (BA;US)

COAL GAS
Biological conversion of synthesis gas into liquid fuels, 14:46800 (RA;US)
Method for enhancing the desulfurization of hot coal gas in a fluid-bed coal gasifier, 14:46831 (P;US)

COAL GASIFICATION
Computational fluid dynamics assessment: Volume 1, Computer simulations of the METC [Morgantown Energy Technology Center] entrained-flow gasifier: Final report, 14:46815 (R;US)
Eighth annual EPRI conference on coal gasification, 14:46823 (R;US)
Mild gasification mechanisms and char conversion, 14:46792 (R;US)
Steam conditioning of coal for synfuels production: Final report, 14:46817 (R;US)

COAL GASIFICATION PLANTS
A review of failure analysis experience on coal-gasification pilot plant components, 14:46830 (BA;US)
Alloy and coating development for coal gasification applications, 14:46828 (BA;US)
Alloy performance in coal gasification environments, 14:47378 (BA;US)
Cost-effective sulfur control strategies for the Great Plains gasification project, 14:46825 (BA;US)
Erosion-corrosion of materials by coal-water slurries, 14:46827 (BA;US)
Market assessment for hydrogen from the catalyzed gasification of low-rank coals, 14:47076 (BA;US)
Materials performance in coal gasification pilot plants, 14:46829 (BA;US)
Method for enhancing the desulfurization of hot coal gas in a fluid-bed coal gasifier, 14:46831 (P;US)

COAL LIQUEFACTION
A study of depolymerization and crosslinking reactions in coal liquefaction: Final report, 14:46820 (R;US)
Coal liquefaction process solvent characterization and evaluation: Technical progress report, July 1–September 30, 1988, 14:46818 (R;US)
Donor hydrogen depletion in coal liquefaction, 14:46793 (R;US)
Two-stage, close coupled catalytic liquefaction of coal: Second quarterly report, January 1, 1989–March 31, 1989, 14:46821 (R;US)
[Free radical and rearrangement reactions in coal liquefaction], 14:46814 (R;US)
[Pittsburgh Energy Technology Center] quarterly technical progress report for the period ending June 30, 1988, 14:46791 (R;US)

COAL LIQUIDS
Characterization, processing, and diesel engine evaluation of coal liquid fuels, 14:46826 (BA;US)

COAL MINERS
Pneumoconiosis in coal miners and exposure to dust of variable quartz content. Final report, December 1985-May 1988, 14:46887 (R;GB)

COAL MINING
Evaluation of air sprays and unique foam application methods for longwall dust control. Research report (Final), 14:46844 (R;US)

COAL PLANERS
See COAL PLOWS

COAL PLOUGHS
See COAL PLOWS

COAL PLOWS
Measuring and control system for coal ploughs - development of a method for identification of the seam/rock interface. Final report, 14:46843 (R;DE;In German)

COAL PREPARATION
[Pittsburgh Energy Technology Center] quarterly technical progress report for the period ending June 30, 1988, 14:46791 (R;US)

COAL PREPARATION PLANTS
Second review of new source performance standards for coal preparation plants. Final report, 14:46841 (R;US)

COAL SEAMS
Causes and control of coal mine bumps, 14:46888 (R;US)
Three-dimensional hydraulic fracture model development for application to and understanding of coal-bed methane-stimulation treatments. Final report, July 1, 1984-December 16, 1988, 14:46913 (R;US)

COAL TAR
Correlations for effects of coal type and pressure on tar yields from rapid devolatilization, 14:46853 (BA;US)

COAL-DERIVED LIQUIDS
See COAL LIQUIDS

COAL-FIRED GAS TURBINES
Proceedings of the sixth annual coal-fueled heat engines and gas stream cleanup systems contractors review meeting, 14:46879 (R;US)

COAL-OIL MIXTURES
See COAL
FUEL OILS
FUEL SLURRIES

COASTAL REGIONS
Combined sewer overflow: A management study. Technical report, 14:48061 (R;US)
Extent and trend of nitrate contamination in Region III: The Coastal Plain and Piedmont Province. Technical report, 14:48034 (R;US)

COASTAL WATERS
Ambient water-quality criteria for ammonia (salt water)-1989, 14:48074 (R;US)
Combined sewer overflow: A management study. Technical report, 14:48061 (R;US)

COATED FUEL PARTICLES
Reference elements for irradiation testing under THTR-follow-up plant conditions to determine safe fission product retention. Final report, 14:47097 (R;DE;In German)
Safety aspects of the Modular High-Temperature Gas-Cooled Reactor (MHTGR), 14:47114 (R;US)

COATING (SURFACE)
See SURFACE COATING

COATING PROCESSES
See SURFACE COATING

COBALT 60
Seasonal dynamics of ^{60}Co uptake by freshwater algae under natural conditions, 14:48047 (R;FR;In French)

COBALT ALLOYS
Spin fluctuations and weak itinerant ferromagnetism in $Y(Co_{1-x}Al_x)_2$ $(0,00 \leq x \leq 0,18)$, 14:47357 (RA;AT;In German)

COBALT COMPLEXES
Preparation, properties, and crystal structure of a novel series of macrocyclic organocobalt complexes, 14:47533 (J;US)
Unusually rapid homolysis of the cobalt-carbon bond in a macrocyclic benzylcobalt complex, 14:47532 (J;US)

COHERENT RADIATION
Summaries of papers presented at the short-wavelength coherent radiation: Generation and applications topical meeting held in Cape Cod, Massachusetts on September 26-29, 1988. Final report, 9 March 1988-1 March 1989, 14:47738 (R;US)

COILS (MAGNETIC)
See MAGNET COILS

COKE-OVEN GAS
See COAL GAS

COLD PLASMA
Nonlinear model of wave-particle interactions in the trapped radiation belts: Auroral-pulsation solutions, 14:48235 (R;US)
Space plasma contractor research, 1988. Annual report, 1 January 1988-1 January 1989, 14:48657 (R;US)

COLD STORAGE
Refrigeration for food and people: an essential technology for the welfare of man, 14:47233 (R;US)

COLLEGES
See EDUCATIONAL FACILITIES

COLLISION MATRIX
See S MATRIX

COLLISIONAL PLASMA
Resistivity of flame plasma in an electric field, 14:48649 (R;JP)

COLLISIONLESS PLASMA
Collisionless tearing instability of a bi-Maxwellian neutral sheet with exact particle orbits. Interim report, 14:48583 (R;US)

COLLISIONS
Geological remote sensing signatures of terrestrial impact craters, 14:48197 (RA;US)

COLOGNE SPIRITS
See ETHANOL

COLOR MODEL
Check of colour symmetry at the LEP collider, 14:48353 (RA;SU)

COLORADO
Preliminary chemical modeling of epithermal processes at Creede, Colorado: The role of fluid mixing as an ore deposition mechanism, 14:47059 (RA;US)
Progressive mineral alteration and coupled ^{18}O depletions in the Lake City hydrothermal system (23 Ma), Colorado, 14:47061 (RA;US)

COLUMBIUM
See NIOBIUM

COLUMNS (MECHANICAL)
See MECHANICAL STRUCTURES

COMBINED GAS AND STEAM CYCLE POWER PLANTS
See COMBINED-CYCLE POWER PLANTS

COMBINED-CYCLE POWER PLANTS
Market assessment for hydrogen from the catalyzed gasification of low-rank coals, 14:47076 (BA;US)

COMBUSTION
Irreversibility reduction of low-temperature, combustion heat sources, 14:47285 (R;US)
[Pittsburgh Energy Technology Center] quarterly technical progress report for the period ending June 30, 1988, 14:46791 (R;US)

COMBUSTION CHAMBERS
A model gas turbine combustor with wall jets and optical access for turbulent mixing, fuel effects, and spray studies, 14:47773 (BA;US)
A simulation with a cellular automaton for turbulent combustion modeling, 14:47586 (BA;US)
Experimental simulation of engine knock by means of a preheated static combustion chamber, 14:47301 (BA;US)
Modelling of confined swirling flows, 14:47777 (R;FI)
Structural analysis applications, 14:47775 (RA;US)
Three dimensional thermal analysis of rocket thrust chambers, 14:47754 (R;US)
Toward improved durability in advanced aircraft engine hot sections, 14:47774 (R;US)

COMBUSTION CONTROL
Engine combustion optimization by exhaust analysis. Final report, December 1986-July 1988, 14:47307 (R;US)

COMBUSTION INSTABILITY
Initiation and suppression of combustion instabilities by active control, 14:47657 (BA;US)

COMBUSTION KINETICS
A model gas turbine combustor with wall jets and optical access for turbulent mixing, fuel effects, and spray studies, 14:47773 (BA;US)
Application of two-component phase Doppler interferometry to the measurement of particle size, mass flux, and velocities in two-phase flows, 14:47469 (BA;US)
Basic research on natural gas combustion phenomena. Annual report, September 1987-August 1988, 14:46918 (R;US)
Laser photolysis shock tube for combustion kinetics studies, 14:47538 (BA;US)
Reaction rates in premixed turbulent flames and their relevance to the turbulent burning speed, 14:47607 (BA;US)
Tabulation of rate constants for combustion modeling, 14:47624 (BA;US)
Toward a quantitative understanding of elementary combustion reactions, 14:47615 (BA;US)

COMBUSTION PRODUCTS
Development of sampling methods for source PM10 emissions. Final report, 14:47951 (R;US)
Estimating air-toxics emission from coal and oil combustion sources. Final report, 14:47953 (R;US)
Federal policy options for indoor air pollution from combustion appliances. Technical report, 14:47968 (R;US)
Formation of NO_x and burnoff of CO during thermal quenching of the products from combustion in a thermally stabilized burner, 14:47642 (BA;US)
Locating and estimating air-toxics emissions from municipal-waste combustors. Final report, August 1988-March 1989, 14:47955 (R;US)
Pulsed plasma jet igniters: Species measurements in methane combustion, 14:47684 (BA;US)

COMBUSTION WAVES
The structures of fast deflagrations and quasi-detonations, 14:47690 (BA;US)

COMBUSTORS
Application of two-component phase Doppler interferometry to the measurement of particle size, mass flux, and velocities in two-phase flows, 14:47469 (BA;US)
MHD (Magnetohydrodynamics) Integrated Topping Cycle: Sixth quarterly progress report, November 1, 1988–January 31, 1989, 14:47258 (R;US)

COMETS
Asteroid and comet flux in the neighborhood of the earth, 14:48208 (RA;US)
Disruption of giant comets in the solar system and around other stars, 14:48213 (RA;US)
New approach to the origin of the tektite in China, 14:48215 (RA;US)
Risk to civilization: A planetary science perspective, 14:48192 (RA;US)

COMMERCIAL SECTOR
Reports published by the Gas Research Institute in the area of residential/commercial appliances and space conditioning: bibliography and abstracts. Update through 1988, 14:46917 (R;US)

COMMERCIALIZATION
Applications of new technologies using a systems approach, 14:48706 (R;US)

COMMUNICATIONS
Communication facility EMP (electromagnetic pulse) assessment. Topical report, 1 September 1975-30 March 1979, 14:47866 (R;US)

COMMUNITIES
Improving state outreach to small communities. Technical report, 14:48060 (R;US)

COMPACT IGNITION TOKAMAK
In-vessel remote maintenance of the Compact Ignition Tokamak, 14:48704 (J;US)
Remote leak detection for the Compact Ignition Tokamak, 14:48705 (J;US)

COMPARTMENTS
GEOTOX multimedia compartment model user's guide supplement, 14:48288 (R;US)
COMPATIBILITY
High-temperature materials compatibility testing of refractory crucible materials: TaC, Y_2O_3, Y_2O_3-coated MgO, and BN, 14:46930 (R;US)
COMPLIANCE AUDITS
Multi-media compliance audit procedures, 1989. Final report, 14:47232 (R;US)
COMPOSITE MATERIALS
Nickel oxide, ceramic-insulated, high-temperature coating, 14:47407 (P;US)
Study of the corrosion of ceramic materials in a simulated advanced glass melter flue-gas environment. Topical report, June 1987-May 1988, 14:47403 (R;US)
Aging
Effect of geometry on thermal aging behavior of Celion/LARC-160 composites, 14:47438 (R;US)
Bonding
Finite element applications to explore the effects of partial bonding on metal matrix composite properties, 14:47436 (R;US)
Chemical Vapor Deposition
Ultrafine microstructure composites prepared by chemical vapor deposition. Annual report, January-December 1988, 14:47408 (R;US)
Creep
Creep behavior of tungsten fiber reinforced niobium metal matrix composites, 14:47351 (R;US)
Fatigue
Strain energy release rate as a function of temperature and preloading history utilizing the edge delamination fatique test method. Contractor resepor, July 1986-October 1988, 14:47441 (R;US)
Fibers
Compressive properties of high-performance polymeric fibers. Interim report, April-December 1988, 14:47412 (R;US)
Heat Treatments
Effect of geometry on thermal aging behavior of Celion/LARC-160 composites, 14:47438 (R;US)
Interfaces
The interface in tungsten fiber reinforced niobium metal-matrix composites, 14:47421 (R;US)
Matrix Materials
Ultrafine microstructure composites prepared by chemical vapor deposition. Annual report, January-December 1988, 14:47408 (R;US)
Mechanical Properties
Finite element applications to explore the effects of partial bonding on metal matrix composite properties, 14:47436 (R;US)
Mechanical Tests
[Mechanical testing of advanced ceramics]: Foreign trip report, April 11–15, 1988, 14:47761 (R;US)
Nondestructive Testing
Study of the stress wave factor technique for evaluation of composite materials. Final report, 14:47440 (R;US)
Physical Radiation Effects
^{13}C NMR analysis of the effects of electron radiation on graphite/polyetherimide composites. Final report, 14:47435 (R;US)
Effects of simulated space environmental parameters on six commercially available composite materials, 14:47434 (R;US)
Protective Coatings
Evaluation of atomic oxygen resistant protective coatings for fiberglass-epoxy composites in LED, 14:47033 (R;US)
Radiation Protection
Evaluation of atomic oxygen resistant protective coatings for fiberglass-epoxy composites in LED, 14:47033 (R;US)
Stability
Effect of geometry on thermal aging behavior of Celion/LARC-160 composites, 14:47438 (R;US)
Stress Relaxation
Strain energy release rate as a function of temperature and preloading history utilizing the edge delamination fatique test method. Contractor resepor, July 1986-October 1988, 14:47441 (R;US)
COMPOSITE MODELS
Size of systems in massless collective states, 14:48327 (R;XA)
COMPOSTING
Study and assessment of eight yard waste-composting programs across the United States. Technical report, 14:47299 (R;US)
COMPOUND-NUCLEUS REACTIONS
Pre-scission particle and gamma-ray emission in heavy-ion induced fission, 14:48428 (R;AU)
COMPOUNDS (ORGANIC)
See ORGANIC COMPOUNDS
COMPRESSION STRENGTH
Compressive properties of high-performance polymeric fibers. Interim report, April-December 1988, 14:47412 (R;US)
COMPUTER ARCHITECTURE
BM/C(3) algorithm mapping onto concurrent processors. Final report, May-December 1987, 14:48719 (R;US)
High-speed parallel-processing networks for advanced architectures, 14:48720 (R;US)
SDS (Space Defense System) software measurement requirements. Technical report, 5 December 1988-6 April 1989, 14:48751 (R;US)
Suitability of message-passing computers for implementing production systems, 14:48715 (R;US)
Supercomputers, architectures and applications, 14:48734 (R;NL;In Dutch)
COMPUTER CODES
3-dimensional non-linear resistive MHD code using semi-implicit method, 14:48652 (R;JP;In Japanese)
Parallel implementation of OPS5 on the Encore multiprocessor: Results and analysis, 14:48714 (R;US)
Software for the computation and graphical display of intensive variable phase diagrams, 14:48170 (RA;US)
The WECHSL-Mod2 code: A computer program for the interaction of a core melt with concrete including the long term behavior. Model description and user's manual, 14:47144 (R;DE)
Thermocapillary flow in a pulsed-laser weld pool, 14:47382 (BA;US)
COMPUTER GRAPHICS
Application of three-dimensional computer solids modeling to TMI-2 [Three Mile Island Unit 2] defueling activities, 14:47197 (J;US)
Organization of DELPHI experimental data analysis. DELPHI interactive graphics centre at JINR, 14:48745 (RA;SU)
COMPUTER LANGUAGES
See PROGRAMMING LANGUAGES
COMPUTER NETWORKS
CALS [Computer-aided Acquisition and Logistic Support Test Network information exchange: User's manual, 14:48748 (R;US)
DSREDS/EDCARS MIL-STD-1840A review, 14:48749 (R;US)
High-speed parallel-processing networks for advanced architectures, 14:48720 (R;US)
COMPUTER PROGRAMS
See COMPUTER CODES
COMPUTER-AIDED DESIGN
Using PATRAN: From eyeballs to submarines and more, 14:48727 (R;US)
COMPUTERIZED CONTROL SYSTEMS
An expert system for automating security incident assessment using OPS5 in an Ada environment, 14:47771 (BA;US)
Concurrent algorithms for a mobile robot vision system, 14:47770 (BA;US)
On estimation of uncertainties in analog measurements, 14:47716 (R;US)
COMPUTERIZED SIMULATION
How can materials theory benefit from supercomputers and vice versa?, 14:47324 (RA;US)
COMPUTERS
Suitability of message-passing computers for implementing production systems, 14:48715 (R;US)

CONCRETES
Service life assesment and examination of concrete structures in renovation, 14:47075 (R;FI;In Finnish)
CONDENSATION (VAPOR)
See VAPOR CONDENSATION
CONDENSATION NUCLEI
Kinetic boundary layer on a sphere and the growth of droplets, 14:48262 (RA;AT;In German)
CONDENSERS (ELECTRIC)
See CAPACITORS
CONDUCTIVITY (THERMAL)
See THERMAL CONDUCTIVITY
CONFERENCES
See MEETINGS
CONFORMAL INVARIANCE
Introduction to W-algebras, 14:48410 (RA;JP)
Non-standard bosonization techniques in conformal field theory, 14:48423 (J;US)
Representation theory of current algebra and conformal field theory on Riemann surfaces, 14:48409 (RA;JP)
Superconformal symmetry and superstring compactification, 14:48383 (J;US)
CONSERVATION (ENERGY)
See ENERGY CONSERVATION
CONSERVATION (RESOURCE)
See RESOURCE CONSERVATION
CONSERVATION LAWS
Continuum-mechanical derivation of the conservation equations for the pyrolysis and combustion of wood. Research report, 14:47029 (R;FI)
Domain decomposition methods for systems of conservation laws: Spectral collocation approximations. Final report, 14:48573 (R;US)
CONSTRUCTION
Landscape dynamics in the Arctic foothills: Progress report, July 1, 1988–August 31, 1989, 14:47972 (R;US)
Wetland soils and vegetation, Arctic Foothills, Alaska, 14:47973 (R;US)
CONTACT RADIOTHERAPY
See RADIOTHERAPY
CONTAINED EXPLOSIONS
Chemical considerations and containment, 14:47901 (RA;US)
Experimental and calculational study of wave/fault interaction, 14:47872 (RA;US)
Geologic and material property combinations that adversely influence residual stress in 2-D dynamic containment calculations, 14:47878 (RA;US)
Junior Jade events - An investigation of decoupling phenomenology, 14:47873 (RA;US)
Reaction kinetics and hydrogen generation, 14:47902 (RA;US)
Recent developments in hydrofracture calculations related to containment, 14:47874 (RA;US)
Simultaneous modeling of dynamic ground motion and fluid flow in hydrofractures, 14:47876 (RA;US)
CONTAINMENT BUILDINGS
Control of the TMI-2 [Three Mile Island Unit 2] reactor building environment, 14:47183 (J;US)
Surface activity characterization with TLD rings, 14:47174 (J;US)
The TMI-2 [Three Mile Island Unit 2] reactor building gross decontamination experiment: Effects on loose-surface contamination levels, 14:47173 (J;US)
Three mile island unit 2 postaccident reactor building entry program, 14:47170 (J;US)
CONTAMINATION
Environmental Radiation Data: report 55, July-September 1988. Quarterly report, 14:47966 (R;US)
CONTAMINATION (SURFACE)
See SURFACE CONTAMINATION
CONTRACT ADMINISTRATION
See CONTRACT MANAGEMENT
CONTRACT MANAGEMENT
Audit of the use of annual appropriations to fund contracts, 14:47210 (R;US)
CONTROL ROOMS
Design criteria and realization of a computerized supervisory system for nuclear applications, 14:47110 (R;IT)
COOLANT-FUEL INTERACTIONS
See FUEL-COOLANT INTERACTIONS
COOLERS
See HEAT EXCHANGERS
COOLING SYSTEM (REACTOR)
See REACTOR COOLING SYSTEMS
COOPER PAIRS
Far infrared spectroscopy on high temperature superconductors. $YBa_2Cu_{3-x}Zn_xO_{7-y}$, 14:47427 (RA;AT;In German)
COPPER
Calculations of resistivity and superconducting T_c in transition metals, 14:48536 (BA;US)
Charge state dependence of K X-ray production in thin targets by multicharged silicon ions, 14:48281 (J;NL)
Microbial dissolution of toxic metals from coal residues, 14:46839 (RA;US)
Model Cu/ZnO catalysts for methanol synthesis: The role of surface structure: Progress report, 14:47025 (R;US)
Polishing methods for metallic and ceramic transmission electron microscopy specimens: Revision 1, 14:47329 (R;US)
Simulation of equilibrium segregation in alloys using the Embedded Atom method, 14:47379 (BA;US)
Thermal conduction of SSC [Superconducting Super Collider] wire, 14:47352 (R;US)
X-ray and γ-ray spectroscopy of solids under pressure: Annual technical progress report, October 1988–October 1989, 14:47471 (R;US)
COPPER 63 TARGET
Measurements of fusion cross section for $^{12}C + ^{63,65}$ Cu systems, 14:48448 (R;BR;In Portuguese)
Nuclear-target effects in J/psi production in anti p and π^- interactions, 14:48440 (J;NL)
Results from WA80 on transverse energy production, fluctuations in multiparticle production, and γ/π^0 ratios, 14:48444 (J;NL)
COPPER 65 TARGET
Measurements of fusion cross section for $^{12}C + ^{63,65}$ Cu systems, 14:48448 (R;BR;In Portuguese)
COPPER ALLOYS
Simulation of equilibrium segregation in alloys using the Embedded Atom method, 14:47379 (BA;US)
COPPER COMPOUNDS
Contribution to the study of the chemical effects of the (n, γ) reaction on copper N-benzoyl N-phenyl hydroxylaminate and copper N-benzoyl N-(o) Tolyl hydroxylaminate, 14:47547 (R;BR;In Portuguese)
Fundamental and applied studies of explosively fabricated high-temperature superconducting fixtures. Quarterly technical report, 1 September-31 November 1988, 14:47386 (R;US)
Preparation and properties of La(2-x)AxCuO(4-y) where A = Pb,Cd. Technical report, 14:47387 (R;US)
Specific heat in mono-crystal YbCo: lambda-like anomalies at 90 and 229K, 14:47402 (R;NO)
COPPER OXIDES
A fermi liquid electric structure and the nature of the carriers in high-T_c cuprates: A photoemission study, 14:48531 (R;US)
Anomalous ion-channeling behavior across the superconducting transition in high-T_c materials, 14:48497 (R;US)
Effects of shock-modification on superconductivity in $Tl_2Ca_2Ba_2Cu_3O_y$ and $Bi_2CaSr_2Cu_2O_x$, 14:47404 (R;US)
Phonons and charge-transfer excitations in HTS superconductors, 14:48532 (R;US)
Superconductivity and magnetic scattering in the $Nd_{2-x}Ce_xCuO_{4-\delta}$, 14:48535 (R;US)
X-ray and γ-ray spectroscopy of solids under pressure: Annual technical progress report, October 1988–October 1989, 14:47471 (R;US)
[Origins of high-temperature superconductivity in the new copper oxide based ceramic superconductors]: Foreign trip report, July 20, 1988–July 29, 1989, 14:48534 (R;US)
CORES (REACTOR)
See REACTOR CORES

CORIUM
INEL [Idaho National Engineering Laboratory] hot shop contamination control during TMI-2 [Three Mile Island Unit 2] core debris handling, 14:47198 (J;US)
Using ex-core neutron detectors to estimate fuel quantities in the reactor vessel lower head, 14:47175 (J;US)
CORONA (SOLAR)
See SOLAR CORONA
CORONA DISCHARGES
Laser Doppler measurements of corona wind velocity, 14:48179 (RA;AU)
Streamer to glow transition in the positive air corona, 14:48238 (RA;AU)
CORONARIES
Imaging of coronary arteries using synchrotron radiation, 14:47459 (J;NL)
CORROSION PRODUCTS
Estimated low-range costs for the removal of inorganics, radionuclides, and corrosion-related contaminants from potable water supplies (draft), January 1987, 14:48039 (R;US)
CORROSION RESISTANT ALLOYS
Alloy performance in coal gasification environments, 14:47378 (BA;US)
COSMIC GAMMA BURSTS
Gamma-ray burster counterparts - Radio, 14:48230 (J;US)
COSMIC GAMMA SOURCES
Angular response calibration of the burst and transient source experiment, 14:47830 (RA;US)
COSMIC MUONS
Sensitivity of high-energy muon flux from atmosphere to parameters of hadronic charm production, 14:48239 (RA;SU;In Russian)
Verification of high energy interaction model using data on cosmic rays in the atmosphere, 14:48177 (RA;PL)
COSMIC NEUTRINOS
Dirac neutrino masses as two-loop radiative corrections, 14:48358 (J;US)
COSMIC PARTICLES
See COSMIC RADIATION
COSMIC POSITRONS
Positron line radiation from halo WIMP annihilations as a dark matter signature, 14:48216 (R;US)
COSMIC RADIATION
Solar-Geophysical Data Number 534, February 1989. Part 1 (prompt reports). Data for January 1989, December 1988, and late data, 14:48219 (R;US)
Solar-Geophysical Data Number 535, March 1989. Part 1 (prompt reports). Data for February, January 1989, and late data, 14:48221 (R;US)
COSMIC X-RAY SOURCES
The status of CYGNUS experiment: Past, present, and future, 14:48183 (R;US)
COSMOLOGICAL CONSTANT
Quantum gravity and cosmological constant, 14:48571 (RA;JP)
COTTON PLANTS
Injury and yield response of cotton to chronic doses of ozone and soil-moisture deficit, 14:48153 (R;US)
COUETTE FLOW
Analytical and numerical studies in flow development: Progress report, 1 July 1988 to Present, 14:48284 (R;US)
COULOMB ATTRACTION
See COULOMB FIELD
COULOMB BARRIER
See COULOMB FIELD
COULOMB FIELD
Auxiliary-field transformations for repulsive potentials: A physical approach, 14:48577 (R;US)
COULOMB POTENTIAL
See COULOMB FIELD
COULOMB REPULSION
See COULOMB FIELD
COUNTERS (RADIATION)
See RADIATION DETECTORS
COVERINGS
Study on large glass covered spaces. Section report of the research project 'Climate and energy', 14:47274 (R;NL;In (In Dutch))
CRATERS
Geological remote sensing signatures of terrestrial impact craters, 14:48197 (RA;US)
Isotopic investigations in the area of the Tunguska catastrophe in 1908 year, 14:48200 (RA;US)
Kara and Ust-Kara impact structures (USSR) and their relevance to the K/T boundary event, 14:48199 (RA;US)
Shatter cones: Diagnostic impact signatures, 14:48204 (RA;US)
CRAY COMPUTERS
TIKTEK: A Tektronix emulator based on 2D GMR, 14:48728 (R;US)
CREEKS
See STREAMS
CRETACEOUS PERIOD
Provenance of the K/T boundary layers, 14:48198 (RA;US)
CRITICAL ASSEMBLIES
See ZERO POWER REACTORS
CRITICALITY
Criticality analysis support for TMI-2 [Three Mile Island Unit 2] fuel removal operations, 14:47195 (J;US)
Criticality prevention during postaccident decontamination of TMI-2 [Three Mile Island Unit 2] plant systems, 14:47196 (J;US)
Nuclear criticality of fuel assembly having infinite multiplication factor less than unity, 14:47109 (R;JP;In Japanese)
CRITICALITY ACCIDENTS
See CRITICALITY
CROPS
Energy analysis of large-scale crop farms: impact of energy crisis and future prospects, 14:47287 (R;FR;In French)
CROSS-LINKING
A study of depolymerization and crosslinking reactions in coal liquefaction: Final report, 14:46820 (R;US)
CROWN ETHERS
See POLYETHYLENE GLYCOLS
CRUDE OIL
See PETROLEUM
CRYOGENIC STORAGE DEVICES
Cryogenic reactant storage for lunar base regenerative fuel cells, 14:47203 (R;US)
CRYOPUMPS
Advanced helium purge seals for Liquid Oxygen (LOX) turbopumps. Final report, September 1985-August 1987, 14:47720 (R;US)
Code development for analysis of TSTA compound cryopumps, 14:48702 (J;US)
CRYSTAL LATTICES
Application of crystal-lattice disintegration criteria to compute minimum shock-induced reactive conditions in solid explosives and inert materials. Final technical report, August 1987-August 1988, 14:47853 (R;US)
CRYSTAL MODELS
Computer simulations of two-dimensional quasiperiodic crystal and random tiling models, 14:47418 (R;US)
CRYSTALS
Reaction rates in cold fusion, 14:48676 (RA;AT;In German)
Search for crystal-catalyzed fusion reactions, 14:48674 (RA;AT;In German)
CUBIC LATTICES
Calcium uranium titanate - a new pyrochlore, 14:47554 (R;AU)
CUPRATES
Complex susceptibility and magnetic properties of (Bi,Pb)SrCaCuO, 14:47390 (RA;AT;In German)
EPR spectra peculiarities of $Y_1Ba_2Cu_3O_{7-x}$ system, 14:48507 (RA;SU;In Russian)
Far infrared spectroscopy on high temperature superconductors. $YBa_2Cu_{3-x}Zn_xO_{7-y}$, 14:47427 (RA;AT;In German)
Fundamental and applied studies of explosively fabricated high-temperature superconducting fixtures. Quarterly technical report, 1 September-31 November 1988, 14:47386 (R;US)

Hall effect in ceramic high-temperature superconductors, 14:47391 (RA;AT;In German)
Influence of doping with Sb, Pb and Ag in the high-temperature superconductor systems Bi-Sr-Ca-Cu-O and Tl-Ba-Ca-Cu-O, 14:47426 (RA;AT;In German)
Mass-spectrometric depth profile analysis of $YBa_2Cu_3O_x$ single crystals, 14:47422 (RA;AT;In German)
Preparation and properties of La(2-x)AxCuO(4-y) where A = Pb,Cd. Technical report, 14:47387 (R;US)
Specific heat in mono-crystal YbCo: lambda-like anomalies at 90 and 229K, 14:47402 (R;NO)
Status of high-temperature superconductors research in Austria, 14:47392 (RA;AT;In German)
Superconductivity and magnetic order in $Y_{1-x}Pr_xBa_2Cu_3O_7$, 14:47425 (RA;AT;In German)

CURIUM COMPOUNDS
Studies on rapid ion-exchange separation of the transplutonium elements with mineral acid-methanol mixed media, 14:47553 (R;JP)

CURRENT DENSITY
Ion bombardment in radio-frequency glow discharges, 14:48504 (RA;AU)

CURRENT-DRIVE HEATING
On the solution of the rotamak current drive equations by expansion in vector spherical harmonics, 14:48625 (RA;AU)
Rotating magnetic field current drive in hot plasmas, 14:48604 (RA;AU)

CYANIDES
Fluorescence studies of OH and CN radicals in atmospheric pressure flames using picosecond excitation, 14:47661 (BA;US)
High temperature rate coefficient for the reaction $CN + O_2 \rightarrow NCO + O$ using different CN-sources, 14:47636 (BA;US)
Measurements of absolute rate coefficients for the reactions of CN radicals with H_2O, H_2, and CO_2 in the temperature range $295\ K \leq T \leq 1027\ K$, 14:47637 (BA;US)

CYCLOALKANES
Cyclopentane formation in the reduction of 1,5-dihaloalkanes with a nickel(I) macrocycle, 14:47023 (J;US)
Utility of cyclodichlorophosphazene as a NaC_5H_5 scavenging reagent: Synthesis of an organoyttrium hydroxide complex and the x-ray crystal structure of the layered compound $((C_5H_5)_2Y(\mu\text{-}OH))_2\ (C_6H_5C{\equiv}CC_6H_5)$, 14 : 47531(*J*; *US*)

CYCLONE COMBUSTORS
An analysis of the behavior of non-slagging, coal fired, cyclone combustors using a phenomenological model, 14:46859 (BA;US)
Development of slag-tap combustor for high intensity pulverized coal combustion, 14:46860 (BA;US)
The use of nonsymmetrical jets for the stabilization of low grade coal flames, 14:46861 (BA;US)

CYLINDERS
Flame propagation for polymers in cylindrical configuration and vertical orientation, 14:47645 (BA;US)

CYTOCHROMES
Study of structure-function relationships in proteins: Techniques and applications ot cytochrome c: Final report January 15, 1988–January 14, 1989, 14:48087 (R;US)

D

D CODES
Physics and Monte Carlo on DELPHI, 14:48317 (RA;SU)

D MESONS
Recent results on hadronic D_s and D meson decays from the Mark III, 14:48321 (R;US)
Symmetry, topology and helicity in $D_s \rightarrow \omega\pi$ and $D_s \rightarrow \rho\pi$ decays, 14:48323 (R;US)

D PLUS RESONANCES
See D MESONS

D-1865 RESONANCES
See D MESONS

DARK MATTER
See NONLUMINOUS MATTER

DATA
An interactive program for constrained spline approximation of numerical data, 14:48735 (R;US)
Operational measures of central tendency, 14:48729 (R;US)

DATA ACQUISITION
A computer program for the IBM-PC/Sheffield air column interface, 14:48730 (R;US)

DATA ACQUISITION SYSTEMS
Detector system for gamma-ray production cross section measurements and data analysis, 14:47829 (R;JP;In Japanese)

DATA ANALYSIS
Scientific data manipulation using attribute constaints, 14:48737 (R;US)

DATA BASE MANAGEMENT
Atomic and molecular database for fusion, 14:48743 (R;JP;In Japanese)
The external design phase of the breeding and multigeneration support system: A tracking and decision support system for NCTR [National Center for Toxicological Research], 14:48746 (R;US)
The internal design phase of the breeding and multigeneration support system: A tracking and decision support system for NCTR [National Center for Toxicological Research], 14:48747 (R;US)

DATA COVARIANCES
Maximum-likelihood identification of structurally constrained covariances for initial-condition statistics, 14:48538 (R;US)

DATA PROCESSING
Construction of a test cell for the laser calibration of the planar ZEUS drift chambers and studies of algorithms for the analysis of FADC signals, 14:47822 (R;DE;In German)
Programming language supporting first-class parallel environments. Technical report, 14:48718 (R;US)

DEBRIS (NUCLEAR)
See FISSION PRODUCTS

DECIMETER WAVE RADIATION (1-3 DM)
See RADIOWAVE RADIATION

DECIMETER WAVE RADIATION (3-10DM)
See RADIOWAVE RADIATION

DEFORESTATION
Contribution of deforestation to atmospheric CO_2 and reforestation as an option to control CO_2, 14:47923 (R;US)

DEHYDROGENASES
See OXIDOREDUCTASES

DELAYED RADIATION INJURIES
See RADIATION INJURIES

DELTA RESONANCES (MESON)
See MESONS

DEMONSTRATION PROGRAMS
Compact car: Drive concept 1990. Final report, 14:47306 (R;DE;In German)

DEOXYPENTOSE NUCLEIC ACID
See DNA

DEOXYRIBONUCLEIC ACID
See DNA

DEPARTMENT OF DEFENSE
See US DOD

DEPLETED URANIUM
Separation of depleted uranium fragments from gun test catchments: Phase 1, Catchment system evaluation and separations methods, 14:46976 (R;US)

DEPLETION (NUCLEAR FUELS)
See BURNUP

DEPOSITS (GEOLOGICAL)
See GEOLOGIC DEPOSITS

DEPTH DOSE DISTRIBUTIONS
Dosimeter readings reproducibility in water phantom measurements at electron accelerators with a beam scanning system, 14:47809 (RA;AT;In German)

DEPTH DOSES
See DEPTH DOSE DISTRIBUTIONS

DESERTRON
See SUPERCONDUCTING SUPER COLLIDER

DESIGN
The external design phase of the breeding and multigeneration support system: A tracking and decision support system for NCTR [National Center for Toxicological Research], 14:48746 (R;US)
DESORPTION
Quantum model of thermal desorption and laser stimulated desorption, 14:47338 (RA;US)
Studies on ions and neutrals desorbed from solid surfaces by ion and electron bombardment. Final report, 1 November 1984-31 October 1988, 14:48494 (R;US)
DESOXYRIBONUCLEIC ACID
See DNA
DETECTION
Measurement methods for low-level ^{129}I determinations, 14:46979 (R;US)
DETECTORS (RADIATION)
See RADIATION DETECTORS
DETONATIONS
A comprehensive model for the structure of dust detonations, 14:47691 (BA;US)
Effects of shock-modification on superconductivity in $Tl_2Ca_2Ba_2Cu_3O_y$ and $Bi_2CaSr_2Cu_2O_x$, 14:47404 (R;US)
Indexes for the proceedings of the symposia (international) on detonation, 1951 through 1985, 14:47855 (R;US)
Model calculations and experimental measurements of the response of HMX porous beds to deflagration and shock, 14:47865 (R;US)
Raman spectroscopic studies of shock-compressed nitromethane and nitromethane-d_3, 14:47861 (R;US)
Shock initiation of LX-17 as a function of its initial temperature, 14:47864 (R;US)
DEUTERIUM
D-^{3}He as fusion fuel, 14:48679 (RA;AT;In German)
Experimental investigations on muon-catalyzed nuclear fusion, 14:48673 (RA;AT;In German)
Measurement of sticking probability in muon-catalysed fusion, 14:48678 (RA;AT;In German)
Some theoretical aspects of cold fusion. A report, 14:48470 (R;XA)
Theoretical study of cold nuclear fusion using barrier penetration approach, 14:48468 (R;XA)
DEUTERIUM IONS
Prediction of new tightly bound-states of $H_2^+(d_2^+)$ and "cold fusion"-experiments, 14:48259 (R;XA)
Stopping power of water vapor for deuterium ions, 14:48264 (RA;AT;In German)
DEUTERIUM TARGET
Reaction rates in cold fusion, 14:48676 (RA;AT;In German)
DEUTERON REACTIONS
Reaction rates in cold fusion, 14:48676 (RA;AT;In German)
Theoretical study of cold nuclear fusion using barrier penetration approach, 14:48468 (R;XA)
DEUTERON-DEUTERON INTERACTIONS
See DEUTERIUM TARGET
DEUTERON REACTIONS
DEVICES
See EQUIPMENT
DEVONIAN SHALES
See BLACK SHALES
DEXTRO AND LEVO OPTICAL ISOMERS
See ENANTIOMORPHS
DIAMINOCAPROIC ACID
See LYSINE
DIAMONDS
Atomic scattering as a probe of physical adsorption, 14:47417 (RA;US)
DIBENZOPYRROLES
See CARBAZOLES
DICHLOROMETHANE
See METHYLENE CHLORIDE
DIESEL ENGINES
A detailed chemical kinetic reaction mechanism for the oxidation of iso-octane and n-heptane over an extended temperature range and its application to analysis of engine knock, 14:47619 (BA;US)
Coal-fueled diesel: Technology development: Final report, 14:47305 (R;US)
Coal-fueled diesels, 14:47312 (BA;US)
Combustion characteristics of dry-coal-powder-fueled adiabatic diesel engine, 14:46884 (BA;US)
Cooper-bessemer coal-fueled engine system, 14:47313 (BA;US)
Engine and constant volume bomb studies of diesel ignition and combustion, 14:47308 (B;US)
Proceedings of the sixth annual coal-fueled heat engines and gas stream cleanup systems contractors review meeting, 14:46879 (R;US)
Progress on the investigation of coal-water-slurry fuel combustion in a medium-speed diesel engine, 14:47314 (BA;US)
DIESEL FUELS
Analysis of diesel sprays through two-dimensional laser light scattering, 14:47470 (BA;US)
Characterization, processing, and diesel engine evaluation of coal liquid fuels, 14:46826 (BA;US)
DIESEL OIL (FRACTION)
See DIESEL FUELS
DIFFERENTIAL EQUATIONS
Generalized BDF [backward differentiation formula] methods applied to Hessenberg form DAEs, 14:48725 (R;US)
Potential for parallelism in explicit linear methods, 14:48724 (R;US)
Structure of a boundary layer in a system of Brownian particles, 14:48261 (RA;AT;In German)
DIFFRACTION (NEUTRON)
See NEUTRON DIFFRACTION
DIGESTER GAS
See METHANE
DIODES (SEMICONDUCTOR)
See SEMICONDUCTOR DIODES
DIOLS
See GLYCOLS
DIOXIN
Epidemiologic investigation of health effects in Air Force personnel following exposure to herbicides. Summary mortality update, 1989. Interim report 1979-1987, 14:48113 (R;US)
Evaluation of high-resolution gas for the determination of 2, 3, 7, 8-TCDD in soil, sediment and water (journal version), 14:47479 (R;US)
Superfund Record of Decision (EPA Region 7): Shenandoah Stables, Missouri (first remedial action), July 1988, 14:48010 (R;US)
DIRAC COSMOLOGY
Dirac neutrino masses as two-loop radiative corrections, 14:48358 (J;US)
DIRAC EQUATION
2D axial anomaly without ambiguity, 14:48405 (RA;AT;In German)
Relativistic corrections for the scattering matrix, 14:48565 (RA;AT;In German)
DIRECTED-ENERGY WEAPONS
Comparison of laser and neutral particle beam discrimination, 14:48752 (R;US)
DIRICHLET PROBLEM
Multigrid techniques with non-standard coarsening and group relaxation methods, 14:48558 (R;XA)
DISARMAMENT
See ARMS CONTROL
DISCHARGES (ELECTRIC)
See ELECTRIC DISCHARGES
DISCHARGES (IONIZATION)
See IONIZATION
DISCHARGES (WASTES)
See WASTE DISPOSAL
DISINTEGRATION (FISSION)
See FISSION
DISMANTLING (REACTOR)
See REACTOR DISMANTLING

DISPOSAL (WASTES)
See WASTE DISPOSAL
DISSOCIATION
Photoexcited charge pair escape and recombination: Progress report, August 1, 1988–August 1, 1989, 14:47539 (R;US)
DISSOLVED OXYGEN
See OXYGEN
DISTILLATION EQUIPMENT
A design and synthesis procedure for homogeneous and heterogeneous azeotropic distillations: Final report, March 1, 1985–February 29, 1988, 14:47718 (R;US)
DISTRIBUTION FUNCTIONS
Quasilinear relaxation of electron distribution function, 14:48632 (RA;AU)
DISTRICT COOLING
District cooling systems central plant technologies: Progress report, 14:47296 (R;US)
DISTRICT HEATING
Life cycle cost analyses of US Air Force heating plants, 14:47208 (R;US)
The influence of the pricing of networked energy carriers on the efficient use of energy in Hesse. Final report, 14:47255 (R;DE;In German)
DIVERTORS
Erosion/redeposition analysis of the ITER [International Tokamak Engineering Reactor] divertor, 14:48666 (R;US)
DNA
Studies on glass support for DNA synthesis, 14:48093 (R;JP)
DNA POLYMERASES
Improved DNA amplification technique, 14:48098 (P;US)
DNA SEQUENCING
Improved DNA amplification technique, 14:48098 (P;US)
DOGS
Collaborative Radiological Health Laboratory annual report 1987: health effects of prenatal and postnatal whole-body exposure to ionizing radiation in the beagle dog. Annual report, 14:48136 (R;US)
DOMESTIC WASTES
See MUNICIPAL WASTES
DOPED MATERIALS
Influence of doping with Sb, Pb and Ag in the high-temperature superconductor systems Bi-Sr-Ca-Cu-O and Tl-Ba-Ca-Cu-O, 14:47426 (RA;AT;In German)
DORMITORIES
See RESIDENTIAL BUILDINGS
DOSE DISTRIBUTIONS
See RADIATION DOSE DISTRIBUTIONS
DOSE EQUIVALENTS
[Agricultural countermeasures following an accidental release of radionuclides]: Foreign trip report, June 11–22, 1989, 14:48049 (R;US)
[Low dose radiation biological bases of risk assessment]: Foreign trip report, September 2-21, 1988, 14:48133 (R;US)
DOSE REDUCTION FACTOR
See RADIOPROTECTIVE SUBSTANCES
DOSE RELATIVE FACTOR
See RADIOPROTECTIVE SUBSTANCES
DOSEMETERS
Evaluation of IREQ [Research institute of Hydro Quebec] electromagnetic dosimeter performance, 14:48160 (R;CA)
DOSIMETERS
See DOSEMETERS
DOSIMETRY
[Training workshop on radiological dose assessment]: Foreign trip report, December 3–8, 1988, 14:48134 (R;US)
DREDGE SPOIL
Engineering and economic analysis of containment area/wetlands disposal options in New York harbor. Final report, 14:48018 (R;US)
DRF
See RADIOPROTECTIVE SUBSTANCES
DRIFT CHAMBERS
Construction of a test cell for the laser calibration of the planar ZEUS drift chambers and studies of algorithms for the analysis of FADC signals, 14:47822 (R;DE;In German)
DRIFT INSTABILITY
Drift wave study in SHEILA heliac, 14:48626 (RA;AU)
DRILL HOLES
See BOREHOLES
DRILL SHIPS
See OFFSHORE PLATFORMS
SHIPS
DRILLING PLATFORMS
See OFFSHORE PLATFORMS
DRINKING WATER
Cost and performance of membranes for organic control in small systems: Flagler Beach and Punta Gorda, Florida. Final report, 1 June 1986-28 February 1989, 14:48038 (R;US)
Cost supplement to technologies and costs for the removal of asbestos from potable-water supplies (first draft), February 1987, 14:48041 (R;US)
Cost supplement to technologies and costs for the removal of selenium from potable-water supplies (first draft), February 1987. Draft report, 14:48043 (R;US)
Cost supplement to the removal of cadmium from potable-water supplies (first draft), February 1987, 14:48042 (R;US)
Drinking-Water Criteria Document for Asbestos (final draft), March 1985, 14:48064 (R;US)
Drinking-Water Criteria Document for Cadmium (final draft), December 1986. Final draft report, 14:48065 (R;US)
Drinking-Water Criteria Document for inorganic mercury (final), July 1988, 14:48066 (R;US)
Drinking-Water Criteria Document for polychlorinated biphenyls (PCBs) (final), April 1988, 14:48067 (R;US)
Drinking-Water Criteria Document for selenium (final draft), December 1986, 14:48068 (R;US)
Estimated low-range costs for the removal of inorganics, radionuclides, and corrosion-related contaminants from potable water supplies (draft), January 1987, 14:48039 (R;US)
Health-risk assessment of trichlorofluoromethane in California drinking water, 14:48150 (R;US)
Information collection request for proposed National Primary Drinking Water Regulations for synthetic organic chemicals (draft), April 1989, 14:48072 (R;US)
Information-collection request for: National Primary Drinking Water Regulations for inorganic chemicals. Phase 2, March 1989, 14:48071 (R;US)
Regulatory impact analysis of proposed National Primary Drinking Water Regulations for synthetic organic chemicals. Phase 2, April 1989, 14:48070 (R;US)
Regulatory impact analysis: Benefits and costs of proposed National Primary Drinking Water Regulations for inorganic chemicals. Phase 2, March 1989, 14:48069 (R;US)
Technologies and costs for the removal of synthetic organic chemicals from potable-water supplies. Appendix A: Estimation of carbon usage rates, March 1989, 14:48044 (R;US)
DROPLETS
Calculations of unsteady reacting droplet flows, 14:47703 (BA;US)
Droplet dispersion and transport mechanisms in a turbulent, free shear-layer, 14:47708 (BA;US)
Unsteady flame propagation in a spray with transient droplet vaporization, 14:47704 (BA;US)
DROUGHTS
Injury and yield response of cotton to chronic doses of ozone and soil-moisture deficit, 14:48153 (R;US)
DRYERS, CLOTHES
See CLOTHES DRYERS
DUCTS
Flame propagation along a vented duct containing grids, 14:47656 (BA;US)
DURENE
Photoexcited charge pair escape and recombination: Progress report, August 1, 1988–August 1, 1989, 14:47539 (R;US)

DUSTS
A comprehensive model for the structure of dust detonations, 14:47691 (BA;US)
Burning rates in turbulent fine dust-air explosions, 14:47693 (BA;US)
Characterization of surface properties affecting the activity of the 'free silica' fraction of respirable dusts. Final report, 14:47943 (R;US)
Comparative study of the influence of obstacles on the propagation of dust and gas flames, 14:47695 (BA;US)
Evaluation of air sprays and unique foam application methods for longwall dust control. Research report (Final), 14:46844 (R;US)
Evaluation of dustiness test methods and recommendations for improved dust control at Heubach Inc., Newark, New Jersey. Study report, 14:47942 (R;US)
Hazards of explosives dusts: Internal report No. 4784, 14:47854 (R;US)
Sampling and evaluating airborne asbestos dust: Course 582, 1988, 14:47938 (R;US)
The investigation of the feature of dispersion induced turbulence and its effects on dust explosions in closed vessels, 14:47694 (BA;US)
Visibility in an atmospheric nuclear dust cloud. Master's thesis, 14:47867 (R;US)

DYE LASERS
Direct solar-pumped iodine laser amplifier. Semiannual progress report, 1 September 1988-28 February 1989, 14:47746 (R;US)
Double-sided coaxial laser, 14:47749 (P;US)

DYMAC SYSTEM
See NUCLEAR MATERIALS MANAGEMENT
PLUTONIUM

DYNAMIC MATERIALS ACCOUNTABILITY SYSTEM
See NUCLEAR MATERIALS MANAGEMENT
PLUTONIUM

DYNAMICS
Theory of singular Lagrangians, 14:48543 (R;XA)

DYNAMICS (BEAM)
See BEAM DYNAMICS

DYSPROSIUM
Temperature and amplitude dependence of internal friction in tantalum, niobium, dysprosium irradiated with electrons, 14:47366 (RA;SU;In Russian)

E

E CODES
EQ3/6 - Status and future development, 14:46959 (RA;US)
EQ3/6 data base - Ongoing development at Lawrence Livermore National Laboratory, 14:46963 (RA;US)
Improvements in the solid solution modeling capabilities of EQ3/6, 14:48168 (RA;US)

EARLY RADIATION INJURIES
See RADIATION INJURIES

EARTH ATMOSPHERE
3-dimensional numerical simulation of the atmospheric injection of aerosols by a hypothetical basaltic fissure eruption, 14:48209 (RA;US)

EARTH CRUST
Explosive volcanism, shock metamorphism and the K-T boundary, 14:48194 (RA;US)
Sudbury Structure (Ontario, Canada) and Vredefort Structure (South Africa): A comparison, 14:48195 (RA;US)

EARTH MAGNETOSPHERE
Collisionless tearing instability of a bi-Maxwellian neutral sheet with exact particle orbits. Interim report, 14:48583 (R;US)
Multipoint measurements from substorm onset to recovery: The relation between magnetic pulsations and plasma-sheet thickening, 14:48236 (R;US)
Nonlinear model of wave-particle interactions in the trapped radiation belts: Auroral-pulsation solutions, 14:48235 (R;US)
Space particle environment. Technical report, 14:48237 (R;US)

EARTH PLANET
Cratering record in the inner solar system: Implications for earth, 14:48191 (RA;US)

EARTHQUAKES
Earthquake recurrence rate estimates for eastern Washington and the Hanford Site, 14:48162 (R;US)

EBR-2 REACTOR
Seismic analysis of the EBR-II [Experimental Breeder Reactor-II] containment structure, 14:47133 (R;US)

EDUCATIONAL FACILITIES
FEDIX: An on-line information service for universities and other research organizations: User's guide, Version 2.0, Release 1, 14:48740 (R;US)

EFFLUENTS (CHEMICAL)
See CHEMICAL EFFLUENTS

EFFLUENTS (GASEOUS)
See GASEOUS WASTES

EFFLUENTS (LIQUID)
See LIQUID WASTES

EFFLUENTS (RADIOACTIVE)
See RADIOACTIVE EFFLUENTS

EHF RADIATION
See MICROWAVE RADIATION

EINSTEIN GRAVITATION THEORY
See GENERAL RELATIVITY THEORY

ELASTIC SCATTERING
Half-shell scattering on Coulomb-distorted Graz potentials, 14:48469 (R;XA)

ELECTRIC BATTERIES
Advanced calcium-thionyl chloride high-power battery. Final report, 23 December 1987-22 December 1988, 14:47204 (R;IL)
Production of EMD (electrolytic manganese dioxide) under different gas atmospheres and its application as a cathode material for lithium secondary batteries, 14:47206 (R;JP)

ELECTRIC CONDENSERS
See CAPACITORS

ELECTRIC DISCHARGES
Investigation of r-f emissions from electric-field-dominated plasmas. Final scientific report, 31 January 1980-31 March 1989, 14:48282 (R;US)

ELECTRIC FIELDS
Investigation of r-f emissions from electric-field-dominated plasmas. Final scientific report, 31 January 1980-31 March 1989, 14:48282 (R;US)

ELECTRIC HEATING
Energy consumption of single-family houses. Partly storing electrical heating, 14:47276 (R;FI;In Finnish)

ELECTRIC MOTORS
Power factor controller study, 14:47282 (R;US)
Starting characteristics of direct current motors powered by solar cells, 14:47043 (R;US)

ELECTRIC POWER
Experimental area power monitoring during shutdown, 14:47785 (R;US)
The influence of the pricing of networked energy carriers on the efficient use of energy in Hesse. Final report, 14:47255 (R;DE;In German)

ELECTRIC POWER SUBSTATIONS
See POWER SUBSTATIONS

ELECTRIC POWER SYSTEMS
See POWER SYSTEMS

ELECTRIC PULSES
See PULSES

ELECTRIC SPARKS
Air breakdown photography in the picosecond domain, 14:47719 (R;US)

ELECTRIC UTILITIES
A supplementary adaptive var unit controller for power system damping, 14:47077 (J;US)
The impact of performance standards on the uncertainty of the Pacific Northwest electric system: A final report on the hypersens analysis of CPAM [Conservation Policy Analysis Model], 14:47080 (R;US)

ELECTRIC-POWERED VEHICLES
Mars manned transportation vehicle, 14:47263 (R;US)
Reluctance motors in efficient variable-speed drive systems. Special report, 14:47315 (R;ZA)
ELECTRICAL ENGINEERING
[School of Electrical Engineering of Purdue University]: Annual research summary, July 1, 1988–June 30, 1989, 14:47244 (R;US)
ELECTRICAL EQUIPMENT
Test fast kicker pulser, 14:47802 (R;US)
ELECTRICAL INSULATORS
An empirical formula for gas switch breakdown delay, 14:47767 (R;US)
ELECTRODES
Doped carbon electrodes for zinc-halogen batteries. Final report, February 1986-July 1986, 14:47205 (R;US)
ELECTROLYTE TILES
See MATRIX MATERIALS
ELECTROLYTIC CELLS
Gas evolution and bubble formation on electrodes, 14:47017 (R;DE;In German)
ELECTROMAGNETIC FIELDS
Evaluation of IREQ [Research institute of Hydro Quebec] electromagnetic dosimeter performance, 14:48160 (R;CA)
Nonlinear hybrid TE-TM waves in a flowing plasma, 14:48643 (RA;AU)
Resistive block methods for electrostatic field solutions with internal elements, 14:48578 (R;US)
Temporal and spatial filtering remedies for dispersion in electromagnetic particle codes, 14:48663 (R;US)
ELECTROMAGNETIC PULSES
Communication facility EMP (electromagnetic pulse) assessment. Topical report, 1 September 1975-30 March 1979, 14:47866 (R;US)
Investigation of radiofrequency/microwave effects upon the central nervous system. Final report, 14:48157 (R;US)
ELECTROMAGNETIC RADIATION
A fully electromagnetic hybrid model for high density plasma simulations, 14:48655 (R;US)
ELECTROMAGNETIC WAVES
See ELECTROMAGNETIC RADIATION
ELECTRON ACCEPTOR
See ELECTRONS
ELECTRON ACOUSTIC WAVES
See ELECTRON PLASMA WAVES
ELECTRON BEAM WELDING
Electron beam welding: Model of high voltage bias transmission line and termination circuits, 14:47377 (R;US)
ELECTRON COLLISIONS
Studies on ions and neutrals desorbed from solid surfaces by ion and electron bombardment. Final report, 1 November 1984-31 October 1988, 14:48494 (R;US)
ELECTRON CONFIGURATION (ATOMS)
See ELECTRONIC STRUCTURE
ELECTRON CYCLOTRON MASERS
See MICROWAVE AMPLIFIERS
ELECTRON DONOR
See ELECTRONS
ELECTRON EMISSION
Secondary electron emission from a metal surface bombarded by slow multiply charged ions, 14:48516 (R;JP)
ELECTRON MICROSCOPY
[Electron-beam induced spectroscopies at very high spatial resolution]: Foreign trip report, April 26–March 12, 1988, 14:47847 (R;US)
ELECTRON MOBILITY
Electron mobility in mercury cadmium telluride, 14:47442 (RA;US)
ELECTRON PARAMAGNETIC RESONANCE
See ELECTRON SPIN RESONANCE
ELECTRON PLASMA WAVES
On lower hybrid wave scattering by plasma density fluctuations, 14:48646 (RA;CS)
Wave particle interactions: Final report, November 6, 1987–October 31, 1988, 14:48661 (R;US)
ELECTRON SPECTROSCOPY
Electron momentum spectroscopy of molecules: a review of recent developments, 14:48251 (R;AU)
ELECTRON SPIN RESONANCE
Electron spin resonance studies of radiation effects in biological materials. An assessment of current and future research, 14:48120 (R;GB)
Radiation-induced paramagnetic centers in quartz blanks of optical waveguides, 14:48509 (RA;SU;In Russian)
ELECTRON-ATOM COLLISIONS
19-state R-matrix calculation of the electron-photon coincidence parameters λ and —chi— for the electron excitation of $1^1s \rightarrow 3^{3,1}p$ in helium at 29.6 eV, 14:48258 (R;XA)
Statistical regularization applied to the analysis of e-He scattering data, 14:48250 (R;AU)
[Electron-impact ionization, Giessen, W. Germany, and visit to Darmstadt, W. Germany, February 28–March 12, 1988]: Foreign trip report, 14:48275 (R;US)
ELECTRON-ELECTRON COLLISIONS
Ionisation of atomic hydrogen at intermediate momentum transfer, 14:48256 (R;AU)
ELECTRON-ION COLLISIONS
[Carbon and oxygen collision data for fusion plasma research]: Foreign trip report, May 7–May 15, 1988, 14:48658 (R;US)
ELECTRON-MOLECULE COLLISIONS
New developments in the ab initio treatment of low energy electron collisions with molecules, 14:48272 (R;US)
New theoretical approaches for studying electron collisions with small molecules, 14:48278 (R;US)
ELECTRON-POSITRON COLLISIONS
Electron-positron annihilation rates in metals, 14:47354 (RA;AT;In German)
On production of supersymmetric Majorana particles in polarized e^+e^- collisions, 14:48337 (RA;PL)
ELECTRON-POSITRON INTERACTIONS
Behaviour of σ_{tot} ($e^+e^- \rightarrow$hadrons) in QCD and in theories with scalar quarks, 14:48351 (RA;SU)
Characteristics of hadron production in e^+e^- annihilation at LEP energy in the frame of the Luna Monte Carlo fragmentation model, 14:48354 (RA;SU)
Check of colour symmetry at the LEP collider, 14:48353 (RA;SU)
Determination of the leptonic neutral current couplings, 14:48303 (RA;PL)
Hadron production and search for new particles at DESY, 14:48305 (RA;PL)
On the process $e^+e^- \rightarrow Z^0 \nu\nu$-bar near the Z^0 threshold, 14:48350 (RA;SU)
Polarization in tau-lepton production at LEP and $\sin^2\Theta_W$, 14:48355 (RA;SU)
Possibility of studying the vertex W-γW in the process $e^+e^- \rightarrow \gamma\nu\nu$-bar, 14:48349 (RA;SU)
Proceedings of the seminar Physics of e^+e^- interactions, 14:48316 (R;SU)
Radiative corrections in two-photon physics, including effects from non-peripheral diagrams, 14:48330 (RA;PL)
Recent results on weak decays from DESY, 14:48309 (RA;PL)
Two-photon physics at LEP, 14:48352 (RA;SU)
ELECTRON-PROTON INTERACTIONS
HERA: the physics and the machine, 14:48311 (RA;PL)
ELECTRON-RING ACCELERATORS
Electromagnetic production of hypernuclei, 14:48322 (J;US)
ELECTRONIC DATA PROCESSING
See DATA PROCESSING
ELECTRONIC EQUIPMENT
HPM [high power microwave] testing of electronic components, 14:47841 (R;US)
ELECTRONIC STRUCTURE
Ab initio calculations of materials properties, 14:47335 (RA;US)
Electron momentum spectroscopy of molecules: a review of recent developments, 14:48251 (R;AU)
Positron annihilation radiation in high-temperature superconductors, 14:47827 (RA;AT;In German)
ELECTRONICS (QUANTUM)
See QUANTUM ELECTRONICS

ELECTRONS
Electron scattering from atoms, 14:48253 (R;AU)
Recombination centres in electron- and neutron irradiated Si diodes, 14:47840 (RA;AT;In German)
Solid-vapor differences of electronic stopping powers for protons, 14:48517 (R;JP)
ELECTROSTATIC WAVES
See PLASMA WAVES
ELEMENTARY PARTICLES
Restrictions on particle masses in supersymmetry, 14:48569 (RA;AT;In German)
EMERGENCY PLANS
Environmental measurements during the TMI-2 [Three Mile Island Unit 2] accident, 14:47171 (J;US)
Local implementation by New England municipalities of the Emergency Planning and Community Right-To-Know Act of 1986 (Title 3 of SARA) (Superfund Amendments and Reauthorization Act). Technical report (Final), 14:47228 (R;US)
EMERGENCY PROVISIONS
See EMERGENCY PLANS
EMISSION
Report on on-line pulverized coal flow meters, 14:47079 (R;FI;In Finnish)
EMISSION (ELECTRON)
See ELECTRON EMISSION
EMITTANCE (BEAM)
See BEAM EMITTANCE
EMP
See ELECTROMAGNETIC PULSES
EMPLOYEES
See PERSONNEL
ENANTIOMORPHS
Temperature-dependent enantiospecificity of secondary alcohol dehydrogenase from Thermoanaerobacter ethanolicus, 14:47530 (J;US)
ENERGY ACCOUNTING
National Energy Accounts, 1958-1985. Technical report (Final), 14:47209 (R;US)
ENERGY CONSERVATION
Assessment of the effect on the gas industry of the National Appliance Energy Conservation Act of 1987. Topical report, November 1988, 14:46908 (R;US)
Federal policy options for indoor air pollution from combustion appliances. Technical report, 14:47968 (R;US)
Heat exchangers: a strategic analysis, 14:47281 (R;FR;In French)
The influence of the pricing of networked energy carriers on the efficient use of energy in Hesse. Final report, 14:47255 (R;DE;In German)
ENERGY CONSUMPTION
National Energy Accounts, 1958-1985. Technical report (Final), 14:47209 (R;US)
ENERGY COSTS
See ENERGY ACCOUNTING
ENERGY DEMAND
GRI (Gas Research Institute) baseline projection methodology and assumptions. Topical report. Revised, 14:47249 (R;US)
GRI (Gas Research Institute) baseline projection regional summary. Topical report, January 1989, 14:47250 (R;US)
ENERGY EFFICIENCY
Energy Division annual progress report for period ending September 30, 1988: Volume 1, 14:47242 (R;US)
ENERGY EFFICIENCY STANDARDS
Assessment of the effect on the gas industry of the National Appliance Energy Conservation Act of 1987. Topical report, November 1988, 14:46908 (R;US)
ENERGY MODELS
GRI (Gas Research Institute) baseline projection methodology and assumptions. Topical report. Revised, 14:47249 (R;US)
GRI (Gas Research Institute) baseline projection regional summary. Topical report, January 1989, 14:47250 (R;US)
ENERGY PERFORMANCE STANDARDS
See ENERGY EFFICIENCY STANDARDS
ENERGY SECURITY ACT
Parachute Creek Shale Oil Program. Environmental monitoring plan, Annual report, October 1, 1987-September 30, 1988, 14:46924 (R;US)
ENERGY SOURCE DEVELOPMENT
Energy, Mines and Resources Canada, 1987-88 estimates. Part 3, expenditure, 14:47211 (R;CA;In English and French)
Parachute Creek Shale Oil Program. Environmental monitoring plan, Annual report, October 1, 1987-September 30, 1988, 14:46924 (R;US)
SOQUIP. Annual report, 1987-1988, 14:47254 (R;CA;In French)
ENERGY SUPPLIES
GRI (Gas Research Institute) baseline projection methodology and assumptions. Topical report. Revised, 14:47249 (R;US)
GRI (Gas Research Institute) baseline projection regional summary. Topical report, January 1989, 14:47250 (R;US)
ENGINEERED SAFETY SYSTEMS
Aging and service wear of electric motor-operated valves used in engineered safety-feature systems of nuclear power plants: Aging assessments and monitoring method evaluations, 14:47147 (R;US)
ENGLAND
See UNITED KINGDOM
ENHANCED RECOVERY
[National Institute for Petroleum and Energy Research] 1988 annual report, 14:46893 (R;US)
ENRICHED MATERIALS (ISOTOPES)
See ISOTOPE ENRICHED MATERIALS
ENRICHED URANIUM
Mathematical determination of α and β for the rotating-slit enrichment monitor, 14:46928 (R;US)
ENTRY CONTROL SYSTEMS
An expert system for automating security incident assessment using OPS5 in an Ada environment, 14:47771 (BA;US)
ENVIRONMENTAL ENGINEERING
Integrated environmental management: A need for change. Technical report, 14:47227 (R;US)
ENVIRONMENTAL EXPOSURE CHAMBERS
See EXPOSURE CHAMBERS
ENVIRONMENTAL IMPACTS
[Uncertainties of environment models in public health and environmental protection]: Foreign trip report, March 3–10, 1989, 14:48117 (R;US)
ENVIRONMENTAL POLICY
Approaches to risk training: An evaluation of EPA (Environmental Protection Agency) risk training materials. Technical report, 14:47229 (R;US)
Integrated environmental management: A need for change. Technical report, 14:47227 (R;US)
ENVIRONMENTAL PROTECTION AGENCY
See US EPA
ENVIRONMENTAL QUALITY
Understanding the estuary: Advances in Chesapeake Bay research, 14:48050 (R;US)
ENZYMES
Antioxidant mechanisms in radiation injury and radioprotection, 14:48118 (R;US)
EPA
See US EPA
EPOXIDES
Epoxy coatings: Anticorrosive and antifouling. January 1980-May 1987 (Citations from World Surface Coatings Abstracts). Report for January 1980-May 1987, 14:47375 (R;US)
Epoxy coatings: Anticorrosive and antifouling. June 1987-May 1989 (Citations from World Surface Coatings Abstracts). Report for June 1987-May 1989, 14:47376 (R;US)
EPOXY COMPOUNDS
See EPOXIDES
EPR
See ELECTRON SPIN RESONANCE
EPR SPECTROMETERS
Small-size spectrometers automated on the base of microprocessors and microcomputers, 14:47844 (RA;SU;In Russian)

EPSILON RESONANCES
See MESONS
EQUATIONS
Existence, uniqueness and approximation of a solution for a K-positive definite operator equation, 14:48549 (R;XA)
EQUATIONS (DIFFERENTIAL)
See DIFFERENTIAL EQUATIONS
EQUATIONS OF MOTION
Integrable classical systems in higher dimensions, 14:48550 (R;XA)
EQUIPMENT
Development of ancillary equipment for a linear accelerator, 14:47808 (RA;AT;In German)
ERBIUM ALLOYS
Rare earth Moessbauer absorption in $ErPd_2Sn$ and $YbPd_2Sn$, 14:47333 (R;FR)
ERBIUM BASE ALLOYS
Magnetic order and magnetic behavior of the polished amorphous eutectic alloys $Tb_{65}Cu_{35}$ and $Er_{69.5}Cu_{30.5}$ - influence of a magnetic field, 14:47334 (R;FR)
ERBIUM OXIDES
Anomalous ion-channeling behavior across the superconducting transition in high-T_c materials, 14:48497 (R;US)
ERRORS
Eequivalence of Gaussian elimination and Gauss-Jordan reduction in solving linear equations, 14:48575 (R;US)
ESCA
See ELECTRON SPECTROSCOPY
ESR
See ELECTRON SPIN RESONANCE
ESTUARIES
Ambient water-quality criteria for ammonia (salt water)-1989, 14:48074 (R;US)
Understanding the estuary: Advances in Chesapeake Bay research, 14:48050 (R;US)
ETA-700 RESONANCES
See MESONS
ETCHING
Effects of plasma confinement on deposition and etch rates, 14:48503 (RA;AU)
Plasma etching of photoresist materials for microelectronic applications, 14:48506 (RA;AU)
ETHANE
Dynamic effects of autoignition centers for hydrogen and $C_{1,2}$-hydrocarbon fuels, 14:47686 (BA;US)
Experiments on the sooting limits of aerodynamically-strained diffusion flames, 14:47570 (BA;US)
ETHANOL
Biological conversion of synthesis gas into liquid fuels, 14:46800 (RA;US)
Radiance, soot, and temperature interactions in turbulent alcohol fires, 14:47646 (BA;US)
Reactions of hydroxymethyl and hydroxyethyl radicals with molecular and atomic oxygen, 14:47626 (BA;US)
ETHINE
See ACETYLENE
ETHYL ALCOHOL
See ETHANOL
ETHYLENE
A kinetic study of ethylene oxidation in a well-stirred reactor, 14:47616 (BA;US)
An investigation of soot formation in axisymmetric turbulent diffusion flames at elevated pressure, 14:47574 (BA;US)
Correlations for smoke points and radiant emission of laminar hydrocarbon diffusion flames, 14:47567 (BA;US)
Dynamic effects of autoignition centers for hydrogen and $C_{1,2}$-hydrocarbon fuels, 14:47686 (BA;US)
Flame-jet ignition of large fuel-air clouds, 14:47655 (BA;US)
Flowfield modeling of soot formation at elevated pressure, 14:47573 (BA;US)
Preferential diffusion and concentration modification in sooting counterflow diffusion flames, 14:47569 (BA;US)
Primary products of the reaction between $O(^3P)$-atoms and C_2H_4 studied with ESR- and LMR-detection, 14:47537 (BA;US)
Propagation mechanism of quasi-detonations, 14:47689 (BA;US)
Radiative properties of chain-agglomerated soot formed in hydrocarbon diffusion flames, 14:47647 (BA;US)
Reactions of vinyl and phenyl radicals with ethyne, ethene and benzene, 14:47630 (BA;US)
Soot aerosol dynamics in a laminar ethylene diffusion flame, 14:47566 (BA;US)
Soot formation in diffusion flames of fuel/oxygen mixtures, 14:47568 (BA;US)
The behavior of polycyclic aromatic hydrocarbons during the early stages of soot formation, 14:47563 (BA;US)
The influence of pressure and temperature on soot formation in premixed flames, 14:47572 (BA;US)
ETHYLENE GLYCOL
See GLYCOLS
ETHYLENE POLYMERS
See POLYETHYLENES
ETHYNE
See ACETYLENE
EUROPE
Development of site remediation technologies in European countries, 14:46994 (RA;US)
Recent progress in coal bioprocessing research in Europe, 14:46798 (RA;US)
EUROPIUM COMPLEXES
Lanthanide shift reagent complexing with quaternary ammonium salts in low-polarity solvents in the presence of water, 14:47522 (RA;SU;In Russian)
X-ray photoelectron spectra and luminescence of europium (3) anthranilates, 14:47509 (RA;SU;In Russian)
EUROPIUM OXIDES
Phonons and charge-transfer excitations in HTS superconductors, 14:48532 (R;US)
EVEN-EVEN NUCLEI
Reduced electric-octupole transition probabilities, $B(E3;O_1^+ \rightarrow 3_1^-)$, for even-even nuclides throughout the periodic table, 14:48427 (R;AU)
EXCHANGE (CHARGE)
See CHARGE EXCHANGE
EXCHANGE (HEAT)
See HEAT TRANSFER
EXERCISE
Influence of the association pyridostigmine-gamma irradiation (15 Gy) on the physical performances of the macacus cynomolgus, 14:48138 (RA;FR;In French)
EXHAUST GASES
Emissions data for stationary reciprocating natural gas engines and gas turbines in use by the gas-pipeline-transmission industry (for microcomputers). Data file, 14:46912 (R;US)
Engine combustion optimization by exhaust analysis. Final report, December 1986-July 1988, 14:47307 (R;US)
Flammability limits for exhaust gas diluted flames, 14:47673 (BA;US)
Flexible Regional Emissions Data System (FREDS) documentation for the 1985 NAPAP (National Acid Precipitation Assessment Program) emissions inventory. Final report, 14:47969 (R;US)
MOBILE4 emission factor model: source code (one version mixed case, one version upper case), input files for example runs, and high-altitude area I/M credits (for microcomputers). Model, 14:47316 (R;US)
Pilot-scale HCl control by dry alkaline injection for emissions from refuse incinerators. Technical report, 14:47946 (R;US)
Resonantly enhanced multiphoton ionization for the trace detection of chlorinated aromatics, 14:47463 (BA;US)
EXPERIMENTAL BREEDER REACTOR-2
See EBR-2 REACTOR
EXPERIMENTAL FACILITIES (ACCELERATOR)
See ACCELERATOR FACILITIES
EXPERT SYSTEMS
Design and implementation of a parallel computer for expert system applications, 14:48739 (BA;US)
Parallelism in rule-based systems, 14:48738 (BA;US)

Troubleshooting complex systems–An expert system, interactive video, transportable PC solution, 14:48722 (R;US)

EXPLORATORY WELLS
Drilling aspects of the deepest well in California, 14:46890 (BA;US)

EXPLOSIONS
Burning rates in turbulent fine dust-air explosions, 14:47693 (BA;US)
Exploding metallic foil fuse modeling at Los Alamos, 14:47766 (R;US)
KIVA reactive hydrodynamics code applied to detonations in high vacuum, 14:47857 (R;US)
The investigation of the feature of dispersion induced turbulence and its effects on dust explosions in closed vessels, 14:47694 (BA;US)

EXPOSURE (RADIATION DOSES)
See RADIATION DOSES

EXPOSURE CHAMBERS
Open-top chamber experiments for investigating the effect of pollutants on growth and health of forest (feasibility study), 14:48142 (R;DE;In German)

EXTREME ULTRAVIOLET RADIATION
Summaries of papers presented at the short-wavelength coherent radiation: Generation and applications topical meeting held in Cape Cod, Massachusetts on September 26-29, 1988. Final report, 9 March 1988-1 March 1989, 14:47738 (R;US)

EXTREMELY HIGH FREQUENCY RADIATION
See MICROWAVE RADIATION

EYES
Analysis and evaluation of technical data on the photochromic and nonlinear optical properties of materials. Quarterly technical report No. 1, 14:48158 (R;US)

F

F-1540 RESONANCES
See MESONS

FABRIC FILTERS
Baghouse efficiency on a multiple-hearth incinerator burning sewage sludge, 14:47950 (R;US)

FACILITIES (ACCELERATOR)
See ACCELERATOR FACILITIES

FACILITIES (EDUCATIONAL)
See EDUCATIONAL FACILITIES

FACILITIES (MILITARY)
See MILITARY FACILITIES

FACILITIES (NUCLEAR)
See NUCLEAR FACILITIES

FACILITIES (STORAGE)
See STORAGE FACILITIES

FACILITIES (TEST)
See TEST FACILITIES

FALLOUT
Comparison of hot particles in the Chernobyl fallout and in the nuclear weapons tests fallout, 14:47960 (RA;AT;In German)
Environmental Radiation Data: report 55, July-September 1988. Quarterly report, 14:47966 (R;US)
Fission-product-decay characteristics. Master's thesis, 14:48463 (R;US)
Vertical distribution of the Chernobyl fallout in snow profiles, 14:47992 (RA;AT;In German)
[Biospheric Model Validation Study (BIOMOVS) and the revision of IAEA safety series No. 57]: Foreign trip report, November 7–23, 1988, 14:47994 (R;US)

FALLOUT PARTICULATES
See FALLOUT
PARTICLES

FARADAY GENERATORS
See MHD GENERATORS

FAST MAGNETOACOUSTIC WAVES
Nonlinear reflection coefficient of the fast magnetoacoustic wave, 14:48647 (RA;CS)

FAST NEUTRONS
Recombination centres in electron- and neutron irradiated Si diodes, 14:47840 (RA;AT;In German)

FATHEAD MINNOW
Effects of acid and aluminum on swim bladder development and yolk absorption in the fathead minnow, pimephales promelas, (journal version), 14:48146 (R;US)

FAULT TOLERANT COMPUTERS
Fault detection and reliability of the GASS (Geophysical Airborne Survey System) multiprocessor survey system, 14:48717 (R;US)

FEDERAL REGION IX
Air quality studies in the western United States, 14:47925 (R;US)

FEDERAL WATER POLLUTION CONTROL ACT
See CLEAN WATER ACT

FERMENTATION ALCOHOL
See ETHANOL

FERMILAB TEVATRON
Calculation of integrated luminosity for beams stored in the Tevatron collider, 14:47794 (R;US)
Exploratory orbit analysis of Tevatron helical upgrade: One: A first look, 14:47793 (R;US)
Report of the Ad Hoc Committee on Test Beam Policy, 14:47784 (R;US)
Tevatron collider: Status and prospects, 14:47783 (R;US)

FERMIONS
Non-perturbative 2D axial-vector-current anomaly, 14:48406 (RA;AT;In German)

FERRITES
Phase I, Volume I, Program summary and PDU [process development unit] operations: Topical report, October 1987–January 1989, 14:46816 (R;US)

FERROMAGNETIC MATERIALS
Method of transforming a passive ferromagnetic material into a permanent magnet, 14:47735 (P;US)
Spin fluctuations and excitations in a 2D xy-ferromagnet: Co-Clsub 2 in graphite, 14:48496 (R;US)

FETUSES
Effect of high radiation doses on human fetuses, 14:48126 (RA;AT;In German)

FIBERGLASS
Static tensile and tensile creep testing of five ceramic fibers at elevated temperatures, 14:47397 (R;US)

FIBERS
Compressive properties of high-performance polymeric fibers. Interim report, April-December 1988, 14:47412 (R;US)

FIBRINOGEN
Platelet thrombosis in cardiac-valve prostheses, 14:48102 (R;US)

FIELD THEORIES
Boundary and crosscap states in conformal field theories, 14:48413 (RA;JP)
Introduction to conformal field theories, 14:48411 (RA;JP)
Milnor monodromy of singularities and chiral primary fields of N=2 superconformal field theories, 14:48394 (R;XA)
Non-perturbative 2D axial-vector-current anomaly, 14:48406 (RA;AT;In German)

FIELDS (ELECTRIC)
See ELECTRIC FIELDS

FIELDS (ELECTROMAGNETIC)
See ELECTROMAGNETIC FIELDS

FIELDS (GRAVITATIONAL)
See GRAVITATIONAL FIELDS

FIELDS (MAGNETIC)
See MAGNETIC FIELDS

FILTERS
Nested-fiber filter for high-temperature and high-pressure particulate removal: Final report, 14:46840 (R;US)

FINANCIAL MANAGMENT
See PROGRAM MANAGEMENT

FINGERPRINTING (OIL SPILLS)
See OIL SPILLS

FIRE FIGHTING
Environmental studies in support of the live fire training facilities project, 14:48028 (R;US)

FIREDAMP
See METHANE
FIRES
EPRI workshop on fire protection in nuclear power plants: Final report, 14:47138 (R;US)
Model experiments of ship fire, 14:47652 (BA;US)
The oscillatory behavior of medium-scale pool fires, 14:47651 (BA;US)
FIREWOOD
See WOOD FUELS
FIRST WALL
High pressure, energy, and impulse loading of the wall in a 1-GJ Laboratory Microfusion Facility, 14:48696 (R;US)
FISHES
Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest): Pile perch, striped seaperch, and rubberlip seaperch, 14:48016 (R;US)
Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (South Atlantic): Black sea bass, 14:48014 (R;US)
FISSION
Nuclear fission induced by heavy ions, 14:48464 (R;AU)
Pre-scission particle and gamma-ray emission in heavy-ion induced fission, 14:48428 (R;AU)
FISSION PRODUCTS
Alpha survey instruments, 14:47153 (BA;US)
Fission-product-decay characteristics. Master's thesis, 14:48463 (R;US)
Polyphase diffusion of fission products in graphite. A contribution about the safety of high temperature reactors, 14:47096 (R;DE;In German)
FISSION RATIO
Experimental investigation of the radial fission product distribution in WWER fuel, 14:47093 (RA;XA)
FISSIONABLE MATERIALS
Nuclear closed-cycle gaseous heat engine concept, 14:47101 (R;US)
FISSIONABLE MATERIALS MANAGEMENT
See NUCLEAR MATERIALS MANAGEMENT
FISSURED FORMATIONS
See FRACTURED RESERVOIRS
FLAME PROPAGATION
A simulation with a cellular automaton for turbulent combustion modeling, 14:47586 (BA;US)
Anomalous Lewis number effects in tribrachial flames, 14:47672 (BA;US)
Fire computation: The flashover phenomenon, 14:47653 (BA;US)
Linear fiber-optic array for measuring the transient propagation of a premixed-charged flame, 14:47701 (BA;US)
Measurement of slow burning velocity by zero-gravity method, 14:47680 (BA;US)
On the mechanisms of flame propagation limits and extinguishment processes at microgravity, 14:47681 (BA;US)
Opposed-flow flame spread and extinction in mixed-convection boundary layers, 14:47668 (BA;US)
Radiation-dominated propagation and extinction of slow, particle-laden gaseous flames, 14:47677 (BA;US)
FLAMES
Acoustics
Driving of axial acoustic waves by side-wall stabilized premixed flames, 14:47658 (BA;US)
Chemical Analysis
Determination of relative number density and decay rate for atomic sodium in an atmospheric premixed flame by Asynchronous Optical Sampling, 14:47468 (BA;US)
Discussion of two-photon laser-excited fluorescence as a method for quantitative detection of oxygen atoms in flames, 14:47467 (BA;US)
Laser-fluorescence measurements of nitric oxide in low-pressure H_2/O_2/NO flames, 14:47640 (BA;US)
Chemical Composition
A structural study of a propane-oxygen diffusion flame diluted with argon, 14:47662 (BA;US)
Chemical structure of fuel-rich, premixed, laminar flames of trichloroethylene, 14:47664 (BA;US)
NH and CH laser-induced fluorescence in low-pressure flames: Quantum yields from time-resolved measurements, 14:47466 (BA;US)
The quantitative LIF (laser-induced fluorescence) determination of OH concentrations in low-pressure flames, 14:47465 (BA;US)
Flow Models
Direct numerical simulations of a two-dimensional reacting, spatially developing mixing layer by a spectral-element method, 14:47593 (BA;US)
Measurement of three-dimensional concentrations in turbulent jets and flames, 14:47599 (BA;US)
Origin and manifestation of flow-combustion interactions in a premixed shear layer, 14:47595 (BA;US)
Reaction rates in premixed turbulent flames and their relevance to the turbulent burning speed, 14:47607 (BA;US)
Study of molecular mixing and a finite rate chemical reaction in a mixing layer, 14:47577 (BA;US)
Velocity and scalar fields of turbulent premixed flames in stagnation flow, 14:47603 (BA;US)
Geometry
Experimental evaluation of the fractal geometry of flamelets, 14:47583 (BA;US)
Fractal geometry applications in turbulent combustion data analysis, 14:47585 (BA;US)
Inhibition
A computational model of the structure and extinction of strained, opposed flow, premixed methane-air flames, 14:47667 (BA;US)
Assessment of theories for the behavior and blowout of lifted turbulent jet diffusion flames, 14:47611 (BA;US)
Coflowing turbulent jet diffusion flame blowout, 14:47610 (BA;US)
Effects of curvature on extinction of premixed flames stabilized in stagnation flow, 14:47670 (BA;US)
Extinction of near-stoichiometric flames diluted with nitrogen in a stagnation flow, 14:47675 (BA;US)
Non-premixed turbulent CO/H_2 flames at local extinction conditions, 14:47589 (BA;US)
On the mechanisms of flame propagation limits and extinguishment processes at microgravity, 14:47681 (BA;US)
Opposed-flow flame spread and extinction in mixed-convection boundary layers, 14:47668 (BA;US)
Radiation-dominated propagation and extinction of slow, particle-laden gaseous flames, 14:47677 (BA;US)
Spontaneous Raman Measurements in turbulent $CO/H_2/N_2$ flames near extinction, 14:47590 (BA;US)
Structure and extinction limits of counterflow diffusion flames of hydrogen-nitrogen mixtures in air, 14:47665 (BA;US)
The structure an extinction of partially premixed flames burning methane in air, 14:47674 (BA;US)
Instability
Lift-off heights in underexpanded natural gas jet flames, 14:47613 (BA;US)
Lifted turbulent jet flames: A stability criterion based on the jet large-scale structure, 14:47612 (BA;US)
Laminar Flow
Interaction of a vortex ring and a laminar flame, 14:47579 (BA;US)
Mathematical Models
Finite chemical reaction rate and local equilibrium effects in turbulent hydrogen-air diffusion flames, 14:47594 (BA;US)
Strained laminar flamelet calculations of premixed turbulent combustion in a closed vessel, 14:47609 (BA;US)
The importance of time-dependent flame structures in stretched laminar flamelet models for turbulent jet diffusion flames, 14:47588 (BA;US)
The stochastic flamelet model of turbulent premixed combustion, 14:47608 (BA;US)
Measuring Methods
Fiber-optic instrumented spark plug for measuring early flame development in spark ignition engines, 14:47310 (B;US)

Laser Mie scattering measurement of mean mixture fraction density and temperature by conditional seeding in a turbulent diffusion flame, 14:47591 (BA;US)

Microstructure
A computational model of the structure and extinction of strained, opposed flow, premixed methane-air flames, 14:47667 (BA;US)
An investigation of the structure of a laminar non-premixed flame in an unsteady vortical flow, 14:47580 (BA;US)
Behavior of methane-oxygen-nitrogen mixtures near flammability limits, 14:47676 (BA;US)
Buoyant diffusion flames, 14:47596 (BA;US)
Chemical structure of fuel-rich, premixed, laminar flames of trichloroethylene, 14:47664 (BA;US)
Detailed numerical simulations of cellular flames, 14:47671 (BA;US)
Evolution of vortical structures in flames, 14:47581 (BA;US)
Experimental and computational investigation of the structure of a sooting C_2H_2-O_2-Ar flame, 14:47562 (BA;US)
Mechanism of flame kernel formation produced by short duration sparks, 14:47303 (BA;US)
Near-field instantaneous flame and fuel concentration structures, 14:47592 (BA;US)
On the flame structure at the base of a pool fire, 14:47650 (BA;US)
Raman/Rayleigh and Mie-scattering measurements in a reverse flow reactor close to extinction, 14:47600 (BA;US)
Recirculating flow over a burning surface - flame structure and heat transfer augmentation, 14:47669 (BA;US)
Scalar dissipation rates in turbulent jets and jet diffusion flames, 14:47598 (BA;US)
Spray-swirl interaction and early pyrolysis of kerosene and light oils spray flames produced by simplex pressure atomizer, 14:47707 (BA;US)
Structural characteristics of lifted turbulent-jet flames, 14:47614 (BA;US)
Structure and extinction limits of counterflow diffusion flames of hydrogen-nitrogen mixtures in air, 14:47665 (BA;US)
Structure of opposed jet premixed flame and transition of turbulent premixed flame structure, 14:47666 (BA;US)
Structures of wet CO flames with full and reduced kinetic mechanisms, 14:47663 (BA;US)
The importance of time-dependent flame structures in stretched laminar flamelet models for turbulent jet diffusion flames, 14:47588 (BA;US)
The inhibiting effect of CF_3H on the structure of a stoichiometric H_2/CO/O_2/Ar flame, 14:47678 (BA;US)
The oscillatory behavior of medium-scale pool fires, 14:47651 (BA;US)
The structure an extinction of partially premixed flames burning methane in air, 14:47674 (BA;US)
The structure of turbulent nonpremixed flames, 14:47576 (BA;US)
Time scales of the scalar field in turbulent premixed conical flames, 14:47605 (BA;US)

Multiphase Flow
Droplet dispersion and transport mechanisms in a turbulent, free shear-layer, 14:47708 (BA;US)

Oscillations
Buoyant diffusion flames, 14:47596 (BA;US)

Stability
Coal combustion models for flame scaling, 14:46857 (BA;US)
The use of nonsymmetrical jets for the stabilization of low grade coal flames, 14:46861 (BA;US)
Transition and stability of turbulent jet diffusion flames, 14:47597 (BA;US)

Strain Rate
Dynamics of stretched flames, 14:47659 (BA;US)
The straining of premixed turbulent flames, 14:47602 (BA;US)

Surface Properties
Fractal-like character of flamelets in turbulent premixed combustion, 14:47584 (BA;US)

Temperature Distribution
The quantitative LIF (laser-induced fluorescence) determination of OH concentrations in low-pressure flames, 14:47465 (BA;US)

Temperature Measurement
SiC-based thin-filament pyrometry: Theory and thermal properties, 14:47702 (BA;US)

Thermal Radiation
Effects of turbulence on flame radiation from diffusion flames, 14:47648 (BA;US)
Turbulence/radiation interactions in nonpremixed hydrogen/air flames, 14:47649 (BA;US)

Turbulent Flow
Effects of turbulence on flame radiation from diffusion flames, 14:47648 (BA;US)
Mean reaction rates in premixed turbulent flames, 14:47606 (BA;US)
Molecular mixing and chemical reactions in turbulent shear layers, 14:47587 (BA;US)
The influence of turbulence on the burning velocity of premixed CH_4-H_2 flames with different laminar burning velocities, 14:47604 (BA;US)
The straining of premixed turbulent flames, 14:47602 (BA;US)
Turbulence/radiation interactions in nonpremixed hydrogen/air flames, 14:47649 (BA;US)

Vortex Flow
Interaction of a vortex ring and a laminar flame, 14:47579 (BA;US)
Premixed combustion in a vortex, 14:47578 (BA;US)
The role of the recirculation vortex in improving fuel-air mixing within swirling flames, 14:47582 (BA;US)

FLASHOVER
Fire computation: The flashover phenomenon, 14:47653 (BA;US)

FLAT PLATE COLLECTORS
Design and construction of thermal solar equipments: flat plate solar collectors, 14:47048 (R;FR;In French)

FLOORS
Contaminated concrete scabbling at the Shippingport Station Decommissioning Project, 14:47000 (R;US)

FLOW (FLUID)
See FLUID FLOW

FLOW MODELS
Role of the turbulent Prandtl number in turbine blade heat transfer prediction, 14:47755 (RA;US)

FLOW RATE
Leaching of ^{14}C and ^{36}Cl from irradiated French graphite, 14:46978 (R;US)
[Groundwater movement models: A review]: Foreign trip report, June 14–17, 1989, 14:48023 (R;US)

FLUE GAS
Flexible Regional Emissions Data System (FREDS) documentation for the 1985 NAPAP (National Acid Precipitation Assessment Program) emissions inventory. Final report, 14:47969 (R;US)
Study of the corrosion of ceramic materials in a simulated advanced glass melter flue-gas environment. Topical report, June 1987-May 1988, 14:47403 (R;US)
System simulation and comparison of advanced flue gas clean-up processes in coal-fired power plant using salt code, 14:47078 (R;US)

FLUID FLOW
Outcome of 1988 work-stay at the University of Strathclyde in Glasgow, Scotland, 14:47267 (R;NL)

FLUID MECHANICS
3D (three-dimensional) Navier-Stokes flow analysis for a large-array multiprocessor. Final technical report, 14 September 1988-29 February 1989, 14:48283 (R;US)
Impulse time-integral function and Lagrangian analysis, 14:48287 (R;US)
Numerical analysis, scientific computing and fundamental studies of fluid mechanics: Final report, April 1, 1986–March 31, 1989, 14:48285 (R;US)

FLUIDIZED BED
See FLUIDIZED BEDS

FLUIDIZED BEDS
Solids motion and heat transfer in gas fluidized beds, 14:47756 (BA;US)

FLUIDIZED-BED COMBUSTION
Second-generation pressurized fluidized bed combustion plant conceptual design: Phase 1, Task 1, Executive summary, 14:47074 (R;US)
FLUIDIZED-BED COMBUSTORS
A combined oxygen/bubble probe for the study of fluidized bed combustion of volatiles, 14:46871 (BA;US)
Mass transfer processes around burning char particles in fluidized beds, 14:46870 (BA;US)
FLUIDS
Structure properties of confined systems. Hard spheres between ideal walls, 14:48500 (R;XA)
FLUORENE
Interactive chemistry of coal-petroleum processing: Quarterly report, March 16, 1989–June 15, 1989, 14:46898 (R;US)
FLUORESCENCE
Fluorescence studies of OH and CN radicals in atmospheric pressure flames using picosecond excitation, 14:47661 (BA;US)
Laser induced fluorescence on the TORTUS tokamak, 14:48601 (RA;AU)
Multiphoton-excited fluorescence measurements of atomic hydrogen in low-pressure flames, 14:47660 (BA;US)
FLUORESCENCE SPECTROSCOPY
Laser-fluorescence measurements of nitric oxide in low-pressure $H_2/O_2/NO$ flames, 14:47640 (BA;US)
FLUORIMETRY
See FLUORESCENCE SPECTROSCOPY
FLUORINATED ALIPHATIC HYDROCARBONS
The SANDIA standard for PVDF [polyvinylidene di-fluoride] shock sensors, 14:47444 (R;US)
FLUORINE 19
Alpha-particle decay widths of levels in ^{19}F, 14:48438 (R;AU)
FLUORINE 22
Reaction studies of the neutron-rich nuclei $^{22,23}F$, 14:48442 (R;AU)
FLUORINE 23
Reaction studies of the neutron-rich nuclei $^{22,23}F$, 14:48442 (R;AU)
FLUOROFORM
The inhibiting effect of CF_3H on the structure of a stoichiometric $H_2/CO/O_2/Ar$ flame, 14:47678 (BA;US)
FLY ASH
Nested-fiber filter for high-temperature and high-pressure particulate removal: Final report, 14:46840 (R;US)
Time-resolved evolution of fly ash during pulverized coal combustion, 14:46865 (BA;US)
FOAMS
Density profiles of a draining foam by nuclear magnetic resonance imaging, 14:46897 (J;US)
Detonation waves through foam, 14:47692 (BA;US)
Ion microbeam tomography, 14:47480 (J;NL)
FOG
Fog, cloud, and dew chemistry. Final report, 14:47940 (R;US)
FOG (SPRAYS)
See SPRAYS
FOILS
Exploding metallic foil fuse modeling at Los Alamos, 14:47766 (R;US)
FOOD
Refrigeration for food and people: an essential technology for the welfare of man, 14:47233 (R;US)
FOODSTUFFS
See FOOD
FORCED CONVECTION
Forced convection heat transfer of interacting spheres, 14:47758 (J;US)
FORESTRY
Investigation on analysing computer-aided forest disease classifications, 14:48141 (R;DE;In German)
FORESTS
Effects of global atmospheric perturbations on forest ecosystems: Predictions of seasonal and cumulative effects, 14:47926 (RA;US)
Evaluation of the methodology for managing existing broadleaved and coniferous woodlands for timber and energy production, 14:47031 (R;GB)
Investigation on analysing computer-aided forest disease classifications, 14:48141 (R;DE;In German)
[Visit to the La Selva Biological Station, Costa Rica]: Foreign trip report, February 28–March 5, 1988, 14:47974 (R;US)
FORMALDEHYDE
Formaldehyde. January 1970-April 1989 (Citations from the NTIS data base). Report for January 1970-April 1989, 14:48154 (R;US)
Theoretical studies of chemical reactions: Pyrolysis of formaldehyde, 14:47262 (RA;US)
FORMALIN
See FORMALDEHYDE
FORMALITH
See FORMALDEHYDE
FORMIC ALDEHYDE
See FORMALDEHYDE
FORMING (MATERIALS)
See MATERIALS WORKING
FORMOL
See FORMALDEHYDE
FORMYL RADICALS
Profiles of HCO and CH_3 in CH_4/O_2 and C_2H_4/O_2 flames by resonance ionization, 14:47462 (BA;US)
FOSSIL FUEL RESERVES
See FOSSIL FUELS
FOSSIL FUELS
Kinetics of the reactions of unsaturated free radicals (methylvinyl and i-C_4H_3) with molecular oxygen, 14:47625 (BA;US)
FOSSIL-FUEL POWER PLANTS
Second-generation pressurized fluidized bed combustion plant conceptual design: Phase 1, Task 1, Executive summary, 14:47074 (R;US)
FRACTURE MECHANICS
Recent developments in hydrofracture calculations related to containment, 14:47874 (RA;US)
FRACTURED FORMATIONS
See FRACTURED RESERVOIRS
FRACTURED RESERVOIRS
An algorithm for mesh simplification applied to fracture hydrology, 14:48163 (J;US)
Fickian filtering of cavity gases rising through a fractured permeable overburden, 14:47905 (RA;US)
Fracture characteristics and reservoir behavior of stress-sensitive fracture systems in flat-lying lenticular formations, 14:46896 (J;US)
FRAGMENTS (FALLOUT)
See FALLOUT
FRAGMENTS (PARTICLES)
See PARTICLES
FRANCE
[Technical Program Committee for the European Nuclear Society/American Nuclear Society meetings]: Foreign trip report, March 26–April 2, 1988, 14:47149 (R;US)
FREE ELECTRON LASERS
Nonlinear resonance: Annual report, 14:47742 (R;US)
Stability requirements of rf linac-driven free-electron lasers, 14:47744 (R;US)
Static periodic field device for free-electron laser, 14:47750 (P;US)
Summaries of papers presented at the short-wavelength coherent radiation: Generation and applications topical meeting held in Cape Cod, Massachusetts on September 26-29, 1988. Final report, 9 March 1988-1 March 1989, 14:47738 (R;US)
FREE RADICALS
See RADICALS
FREONS
Health-risk assessment of trichlorofluoromethane in California drinking water, 14:48150 (R;US)
FUEL ADDITIVES
Promoted high-temperature reactions, 14:47620 (BA;US)

FUEL ASSEMBLIES
Experimental investigation of the radial fission product distribution in WWER fuel, 14:47093 (RA;XA)
Heavy isotope method for burnup determination of HFETR fuel elements, 14:47123 (RA;XA)
Non-destructive burnup determination: Experimental investigation on low burnup gadolinia fuel, 14:47089 (RA;XA)
Non-destructive measurements of water reactor fuel and evaluation of measurement techniques for improved assay accuracy, 14:47092 (RA;XA)
Nuclear criticality of fuel assembly having infinite multiplication factor less than unity, 14:47109 (R;JP;In Japanese)
Passive neutron verification of WWER-440 spent fuel burnup, 14:47091 (RA;XA)
Techniques and equipment for determination of fuel burnup in water cooled reactors, 14:47090 (RA;XA)

FUEL CELLS
Fuel cells for vehicle propulsion applications: A thermodynamic systems analysis, 14:47261 (R;US)

FUEL COOLING INSTALLATIONS
See SPENT FUEL STORAGE

FUEL CYCLE
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FUEL ELEMENT FAILURE
The impact of fuel cladding failure events on occupational radiation exposures at nuclear power plants, 14:47155 (BA;US)

FUEL ELEMENTS
Burnup determination of water reactor fuel. Proceedings of a technical committee meeting held in Karlsruhe, 13-16 June 1988, 14:47085 (R;XA)
Reference elements for irradiation testing under THTR-follow-up plant conditions to determine safe fission product retention. Final report, 14:47097 (R;DE;In German)
[Status of the PHEBUS-FR severe accident research project]: Foreign trip report, November 13–18, 1988, 14:47150 (R;US)

FUEL FABRICATION PLANTS
Application for approval for construction of the Fueled Clad Fabrication System, the Radioisotope Power Systems Facility, and the Fuel Assembly Area, 14:46929 (R;US)

FUEL INJECTION SYSTEMS
Progress on the investigation of coal-water-slurry fuel combustion in a medium-speed diesel engine, 14:47314 (BA;US)

FUEL KERNELS
See FUEL PARTICLES

FUEL MANAGEMENT
IAEA in-core fuel management activities, 14:47086 (RA;XA)

FUEL OILS
Spray-swirl interaction and early pyrolysis of kerosene and light oils spray flames produced by simplex pressure atomizer, 14:47707 (BA;US)

FUEL PARTICLES
Development of hot nitrogen kernel, produced by a very fast spark discharge, 14:47304 (BA;US)
Mechanism of flame kernel formation produced by short duration sparks, 14:47303 (BA;US)

FUEL REPROCESSING
See REPROCESSING

FUEL REPROCESSING PLANTS
Development of the computer code TRANS-ACE for analysing radioactive materials transport in reprocessing plants under accidental conditions, 14:46931 (R;JP;In Japanese)
Safety demonstration test on solvent fire in fuel reprocessing plant, 14:46932 (R;JP;In Japanese)

FUEL SCANNING
Determination of radial gadolinium burnup in LWR fuel by secondary ion mass spectrometry (SIMS), 14:47478 (RA;XA)

FUEL SLURRIES
Coal-fueled diesel: Technology development: Final report, 14:47305 (R;US)
Combustion of coal char agglomerates in a combustion gas environment, 14:46851 (BA;US)
Erosion-corrosion of materials by coal-water slurries, 14:46827 (BA;US)
Evaporation, agglomeration, and explosive boiling characteristics of coal-water fuels under intense heating conditions, 14:46877 (BA;US)
Particle rotation in coal combustion: Statistical, experimental and theoretical studies, 14:46856 (BA;US)
Pre-ignition phenomena and their effects on overall combustion rates of coal slurry droplets, 14:46878 (BA;US)
Progress on the investigation of coal-water-slurry fuel combustion in a medium-speed diesel engine, 14:47314 (BA;US)
Roles of additives and surface control in slurry atomization: Quarterly report, 14:46833 (R;US)
The use of nonsymmetrical jets for the stabilization of low grade coal flames, 14:46861 (BA;US)

FUEL SPHERES
Forced convection heat transfer of interacting spheres, 14:47758 (J;US)

FUEL SUBSTITUTION
[USDOE's federal methanol fleet report to the international symposium on alcohol fuels]: Foreign trip report, November 10, 1988–November 23, 1988, 14:47317 (R;US)

FUEL SUSPENSIONS
See FUEL SLURRIES

FUEL-AIR RATIO
Engine combustion optimization by exhaust analysis. Final report, December 1986-July 1988, 14:47307 (R;US)
Reduction of NO_x emission in turbulent combustion by fuel-staging/effects of mixing and stoichiometry in the reduction zone, 14:46915 (BA;US)
The role of the recirculation vortex in improving fuel-air mixing within swirling flames, 14:47582 (BA;US)

FUEL-COOLANT INTERACTIONS
Steam explosion triggering and propagation: Hypotheses and evidence, 14:47152 (R;US)

FUELS
Contract R&D technically administered by the Energy Research Laboratories. FY 1985/86, 14:47239 (R;CA)
Recirculating flow over a burning surface - flame structure and heat transfer augmentation, 14:47669 (BA;US)
Study of molecular mixing and a finite rate chemical reaction in a mixing layer, 14:47577 (BA;US)

FUELWOOD
See WOOD FUELS

FUMES
See AEROSOLS

FUNDAMENTAL PARTICLES
See ELEMENTARY PARTICLES

FUNGI
Depolymerization of low-rank coals by a unique microbial consortium, 14:46801 (RA;US)
Enzymatic degradation of low-rank coals by a cell-free enzymatic system from coriolus versicolor, 14:46804 (RA;US)

FUSES
Exploding metallic foil fuse modeling at Los Alamos, 14:47766 (R;US)

FUSION (NUCLEAR)
See THERMONUCLEAR REACTIONS

FUSION ENERGY
See THERMONUCLEAR REACTORS

FUSION FUELS
See THERMONUCLEAR FUELS

FUSION REACTORS
See THERMONUCLEAR REACTORS

FUZES
See FUSES

G

G CODES
Thermodynamic and kinetic modeling of glass leaching in a waste package environment, 14:46962 (RA;US)

User's manual of self learning gas puffing system for plasma density control, 14:48726 (R;JP;In Japanese)

GADOLINIUM 155
Determination of radial gadolinium burnup in LWR fuel by secondary ion mass spectrometry (SIMS), 14:47478 (RA;XA)

GADOLINIUM 157
Determination of radial gadolinium burnup in LWR fuel by secondary ion mass spectrometry (SIMS), 14:47478 (RA;XA)

GADOLINIUM COMPLEXES
ODMR study of excited trip-multiplet states of Gd(3) complexes (ODMR-optical detection of microwave resonances.), 14:47500 (RA;SU;In Russian)

GADOLINIUM COMPOUNDS
ENDOR spectroscopy of admixture ions in crystals of inorganic chlorides, 14:47486 (RA;SU;In Russian)

GADOLINIUM OXIDES
Determination of radial gadolinium burnup in LWR fuel by secondary ion mass spectrometry (SIMS), 14:47478 (RA;XA)

GAGES (PRESSURE)
See PRESSURE GAGES

GALAXY CLUSTERS
Dynamics of superclusters - reconciling Omega(0) = 1.0 with observations?, 14:48229 (J;US)

GALLIUM 67
Standardization of ^{67}Ga by liquid scintillation coincidence counting, 14:48492 (R;ZA)

GALLIUM ANTIMONIDES
Investigations of the quantum photovoltaic effect in InAs-GaSb semiconductor superlattices, 14:47413 (R;US)

GALLIUM ARSENIDE SOLAR CELLS
Characterization of production GaAs solar cells for space, 14:47032 (R;US)

GALLIUM ARSENIDES
Ion beam processes in advanced electronic materials and device technology, 14:47449 (B;US)
MeV implantation studies in LPE (liquid phase epitaxy)-grown GaAs and InP. Final report, 1 October 1987-31 March 1989, 14:47411 (R;US)
Strain and density dependent valence-band masses in InGaAs/GaAs and GaAs/GaAsP strained-layer structures, 14:47447 (R;US)
Wavefunctions and charge densities for defects in solids: A success for semiempirical theory, 14:47341 (RA;US)
[Thermodynamics, kinetics, and interfare morphologies of phase formation reactions between metals and gallium arsenide: Bulk vs thin-film studies], 14:47420 (R;US)

GALLIUM PHOSPHIDES
Wavefunctions and charge densities for defects in solids: A success for semiempirical theory, 14:47341 (RA;US)

GAMMA RADIATION
RBE [relative biological effectiveness] of tritium beta radiation to gamma radiation and x-rays analyzed by both molecular and genetic methods, 14:48121 (R;US)

GAMMA SPECTROMETERS
Angular response calibration of the burst and transient source experiment, 14:47830 (RA;US)

GAMMA-RAY LASERS
See GASERS

GAS APPLIANCES
Advanced-technology gas-fired commercial clothes dryer. Final report, April 1985-December 1988, 14:46907 (R;US)
Assessment of the effect on the gas industry of the National Appliance Energy Conservation Act of 1987. Topical report, November 1988, 14:46908 (R;US)
Reports published by the Gas Research Institute in the area of residential/commercial appliances and space conditioning: bibliography and abstracts. Update through 1988, 14:46917 (R;US)
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GAS BURNERS
Advanced indirect gas-fired heating system. Final report, August 15, 1984-June 30, 1988. Phase 2: Development. Phase 3: Application, 14:46919 (R;US)

GAS COOLANTS
See GASES

GAS ENGINES
See INTERNAL COMBUSTION ENGINES

GAS FLOW
Unsteady hydromagnetic flow of a radiating gas in a vertical channel with axial temperature variation, 14:48286 (R;XA)

GAS FURNACES
Advanced indirect gas-fired heating system. Final report, August 15, 1984-June 30, 1988. Phase 2: Development. Phase 3: Application, 14:46919 (R;US)

GAS TURBINE ENGINES
Emissions data for stationary reciprocating natural gas engines and gas turbines in use by the gas-pipeline-transmission industry (for microcomputers). Data file, 14:46912 (R;US)
High speed balancing applied to the T700 engine. Final report, 14:47776 (R;US)
Nickel oxide, ceramic-insulated, high-temperature coating, 14:47407 (P;US)
Structural analysis applications, 14:47775 (RA;US)
Toward improved durability in advanced aircraft engine hot sections, 14:47774 (R;US)

GAS TURBINES
Emissions data for stationary reciprocating natural gas engines and gas turbines in use by the gas-pipeline-transmission industry (for microcomputers). Data file, 14:46912 (R;US)

GAS WELLS
See NATURAL GAS WELLS

GASEOUS EFFLUENTS
See GASEOUS WASTES

GASEOUS WASTES
Air quality studies in the western United States, 14:47925 (R;US)
Lessons learned from a review of post-accident sampling systems, high range effluent monitors and high concentration particulate iodine samplers, 14:47154 (BA;US)

GASERS
Proof of the feasibility of coherent and incoherent schemes for pumping a gamma-ray laser. Quarterly technical progress report, 1 October-31 December 1988, 14:48462 (R;US)

GASES
Comparative study of the influence of obstacles on the propagation of dust and gas flames, 14:47695 (BA;US)
Conventional weapons demilitarization: A health and environmental effects data base assessment: Methods for estimating multi-pathway exposures to environmental contaminants, Final report, Phase 2, 14:48155 (R;US)
Detonation waves through foam, 14:47692 (BA;US)
Equations of state for hard-sphere fluids, 14:47759 (J;US)
Kinetic boundary layer of the linearized Boltzmann equation at a partly absorbing sphere, 14:48260 (RA;AT;In German)
Laboratory study of nitrogen miscible displacement of light oil, 14:46892 (R;US)
Selected equation of state in the acentric factor system, 14:47760 (J;US)
Solution of the non-linear Boltzmann equation for a homogeneous hard-sphere gas, 14:48263 (RA;AT;In German)

GASIFICATION
Updraft gasification of waste fuels, 14:47020 (R;FI;In Finnish)

GASKETS
Fractal dimension of a quasi-two-dimensional Sierpinski gasket as a conductor, 14:48501 (R;XA)

GASOLINE
The Department of Energy's Federal Methanol Fleet, 14:47028 (B;US)

GASOLINE ENGINES
See INTERNAL COMBUSTION ENGINES

GAUGE INVARIANCE
Anomalies in gauge and supersymmetric gauge theories, 14:48401 (RA;PL)

Divergences and involution-dependent constants, 14:48422 (J;US)
Superspace quantization of gauge theories: gauge-fixing and ghost terms in N=1 supergravity, 14:48402 (RA;PL)
Two dimensional conformal gauge theories, 14:48414 (RA;JP)

GAUGE TRANSFORMATIONS
See GAUGE INVARIANCE

GEIGER-MUELLER COUNTERS
Characteristics of Geiger-Mueller counters used in neutron dosimetry applications, 14:47832 (R;ZA)

GENE AMPLIFICATION
Improved DNA amplification technique, 14:48098 (P;US)

GENE LOCI
See GENES

GENERAL RELATIVITY THEORY
Are gravitons windows to higher dimensions, 14:48552 (R;XA)

GENERATORS (PULSE)
See PULSE GENERATORS

GENES
[Endogenous retrotransposable gene elements af human genome in high incidence cancers]: Foreign trip report, December 6, 1988–March 6, 1989, 14:48090 (R;US)

GENETIC EFFECTS
[Dose and dose-rate effects on radiation response]: Foreign trip report, May 5–13, 1989, 14:48135 (R;US)

GENETIC ENGINEERING
Improved DNA amplification technique, 14:48098 (P;US)
Selectable sets of novel proteins: catalytic and other properties. Final report, 1 July-30 September 1988, 14:48099 (R;US)

GEOCHEMISTRY
Calculations of geochemical mass transfer as a function of temperature and time, 14:48167 (RA;US)
Computer modeling of the aqueous geochemistry of the Archean hydrosphere and the formation of banded iron formations, 14:48169 (RA;US)
EQ3/6 - Status and future development, 14:46959 (RA;US)
Evaluation of an equilibrium speciation model for the acid aqueous iron sulfate system at 25°C, 14:46838 (RA;US)
Multiple reaction path model describing mass transfer in geochemical systems, 14:48165 (RA;US)

GEOLOGIC DEPOSITS
Noble metals in mid-ocean ridge volcanism: A significant fractionation of gold with respect to platinum group metals, 14:48193 (RA;US)

GEOLOGIC FAULTS
Experimental and calculational study of wave/fault interaction, 14:47872 (RA;US)
Pre- and post-event elevation and horizontal surveys across the Yucca and Topgallant faults, Nevada Test Site, 14:47893 (RA;US)

GEOLOGIC FORMATIONS
Prototype Borehole Directional Radar System, 14:47852 (R;US)

GEOLOGIC FRACTURES
An algorithm for mesh simplification applied to fracture hydrology, 14:48163 (J;US)

GEOLOGIC HISTORY
Impact, and its implications for geology, 14:48203 (RA;US)

GEOMAGNETIC FIELD
Magnetic reversal spurts: Rain gauges for comet showers, 14:48202 (RA;US)
Solar-Geophysical Data Number 535, March 1989. Part 1 (prompt reports). Data for February, January 1989, and late data, 14:48221 (R;US)

GEOMAGNETIC STORMS
See MAGNETIC STORMS

GEOMETRY
What can we do with only a pair of rusty compasses, 14:48542 (R;XA)

GEOPHYSICAL SURVEYS
Devonian shale-specific computation methodology. Topical report, June 1988, 14:46906 (R;US)

GEOTHERMAL DISTRICT HEATING
A materials and equipment review of selected US geothermal district heating systems, 14:47057 (R;US)

GEOTHERMAL ENERGY
DOE research and development for the geothermal marketplace: Geothermal program review 7: Proceedings, 14:47051 (R;US)

GEOTHERMAL FLUIDS
Boiling of geothermal waters: precipitation of base and precious metals, speciation of arsenic and antimony, and the role of gas phase metal transport, 14:47060 (RA;US)

GEOTHERMAL POWER PLANTS
Preliminary assessment of offshore platform conversion to geothermal power station, 14:47052 (R;GB)

GERMAN DEMOCRATIC REPUBLIC
Environmental impacts of Chernobyl reactor accident in German Democratic Republic, 14:47130 (R;FR;In French)

GERMANIUM
Charge state dependence of K X-ray production in thin targets by multicharged silicon ions, 14:48281 (J;NL)
X-ray and γ-ray spectroscopy of solids under pressure: Annual technical progress report, October 1988–October 1989, 14:47471 (R;US)

GERMANIUM IODIDES
^{79,81}Br, ^{127}I NQR study of Tl-containing inorganic compounds, 14:47502 (RA;SU;In Russian)
High pressure ^{129}I Moessbauer studies of GeI_4 molecular crystals, 14:48518 (R;US)

GERMANY (DEMOCRATIC REPUBLIC)
See GERMAN DEMOCRATIC REPUBLIC

GERMS (MICROORGANISMS)
See MICROORGANISMS

GIANT RESONANCE
[Coulomb excitation with fast high Z ions: Gamma-gamma coincidence study of the IVGQR and the two-phonon giant resonance states in ^{208}Pb]: Foreign trip report, April 14–19, 1989, 14:48459 (R;US)

GLASS
Crystallization kinetics of $BaO\text{-}Al_2O_3\text{-}SiO_2$ glasses, 14:47396 (R;US)
Studies on glass support for DNA synthesis, 14:48093 (R;JP)
Surface structure of silica glasses by molecular dynamics simulations, 14:47453 (BA;US)

GLUONS
Hermeticity requirements at SSC [Superconducting Super Collider], 14:48290 (R;US)
Quark confinement in supersymmetric QCD, 14:48344 (RA;AT;In German)

GLUTATHIONE
Antioxidant mechanisms in radiation injury and radioprotection, 14:48118 (R;US)

GLYCOLS
Superfund Record of Decision (EPA Region 9): MGM Brakes site, Cloverdale, California (first remedial action), September 1988. Final report, 14:48054 (R;US)

GOBAR GAS
See METHANE

GOLD
Electronic structure of transition metal alloys and intermetallics: Charge transfer and its inplications for Moessbauer effect measurements, 14:47331 (R;US)

GOLD 197 TARGET
Fluctuations in transverse energy and multiplicity, energy densities, and neutral pion spectra in nucleus-nucleus collissions at 200 GeV/nucleon, 14:48458 (R;US)
Multifragmentation and fission in the reactions Nb + Au and Fe + Au at 50 to 100 MeV/A, 14:48460 (R;US)
Pion interferometry of O+Au at 200 AGeV, 14:48486 (J;NL)
Results from WA80 on transverse energy production, fluctuations in multiparticle production, and γ/π^0 ratios, 14:48444 (J;NL)
Strangeness production in Si + Au interactions at 14.6 GeV/c per nucleon, 14:48293 (R;US)

GOLD IODIDES
Structure-property relationships as an aid in the rational design of β-$(ET)_2X$ organic superconductors, 14:47347 (R;US)

GRAIN ALCOHOL
See ETHANOL

GRAND UNIFIED THEORY
Grand unification: quo vadis domine?, 14:48404 (RA;PL)
GRANITES
Camborne geothermal energy project 2C-7 resource evaluation. V. 2. Seismic reflection survey, 14:47054 (R;GB)
GRAPHITE
Atomic scattering as a probe of physical adsorption, 14:47417 (RA;US)
Polyphase diffusion of fission products in graphite. A contribution about the safety of high temperature reactors, 14:47096 (R;DE;In German)
The role of peripheral percolation in detachment of fines from burning carbon particles, 14:46847 (BA;US)
GRAPHITE MODERATOR
See GRAPHITE
GRASERS
See GASERS
GRAVITATION
(2+1)-dimensional pure gravity for an arbitrary closed initial surface, 14:48576 (R;JP)
GRAVITATIONAL FIELDS
High-sensitivity hillside results from the Eoet-Wash experiment, 14:47823 (R;US)
GRAVITATIONAL LENSES
Gravitational lens effect on the cosmic background radiation due to nonlinear inhomogeneities, 14:48223 (R;JP)
GREAT BRITAIN
See UNITED KINGDOM
GREEN FUNCTION
Simple proof of renormalization group equation in the minimal subtraction scheme, 14:48386 (R;XA)
GREEN RIVER FORMATION
FY 1988 USGS [US Geological Survey] annual report, 14:46905 (R;US)
GREENHOUSE EFFECT
Ozone depletion, greenhouse gases, and climate change: Proceedings, 14:47924 (R;US)
GREENLAND
Origin of density enhancements in the winter polar-cap ionosphere, 14:48233 (R;US)
GROUND MOTION
Preliminary surface ground motion calculations with the SHALE code, 14:47877 (RA;US)
Simultaneous modeling of dynamic ground motion and fluid flow in hydrofractures, 14:47876 (RA;US)
GROUND WATER
Contamination
An evaluation of the use of a combination of ozone, ultraviolet radiation, and hydrogen peroxide to remove chlorinated hydrocarbons from groundwater at the Department of Energy Kansas City Plant: Fiscal year 1988, annual report, 14:48026 (R;US)
Feasibility of adding TCE [trichloroethylene] still area and Northeast area plumes to ultraviolet radiation, ozone, hydrogen peroxide groundwater treatment plant, Department of Energy Kansas City Plant, 14:48025 (R;US)
Remedial investigation of the High Explosives Burn Pit facility, Building 829 complex, Lawrence Livermore National Laboratory site 300, 14:47862 (R;US)
[Groundwater movement models: A review]: Foreign trip report, June 14–17, 1989, 14:48023 (R;US)
[Water-rock interaction]: Foreign trip report, August 1–15, 1989, 14:48024 (R;US)
Flow Rate
[Review three interim reports on numerical modeling, tracer study, and monitoring design]: Foreign trip report, January 18–27, 1989, 14:46971 (R;US)
Fluid Flow
Matrix diffusion user guide (release 2), 14:47987 (R;GB)
Temperature logging as an aid to understanding groundwater flow in NTS boreholes, 14:47908 (RA;US)
Land Pollution
Superfund Record of Decision (EPA Region 9): MGM Brakes site, Cloverdale, California (first remedial action), September 1988. Final report, 14:48054 (R;US)
Superfund Record of Decision: (EPR Region 6): Curley Pit Site, ground-water operable unit, Crittenden County, Arkansas (second remedial action), September 1988. Final report, 14:48055 (R;US)
Measuring Methods
Development and testing of a physical measurement system for exploring heated groundwater flows, e.g. for heat recovery with the aid of water/water heat pumps, 14:47286 (R;DE;In German)
Radionuclide Migration
Matrix diffusion user guide (release 2), 14:47987 (R;GB)
Samplers
Generalized ground-water sampling device matrix (journal version), 14:48032 (R;US)
Sampling
Stability of volatile organics in environmental water samples: Storage and preservation: Final report, 14:48029 (R;US)
Water Currents
Development and testing of a physical measurement system for exploring heated groundwater flows, e.g. for heat recovery with the aid of water/water heat pumps, 14:47286 (R;DE;In German)
Water Pollution
Fiscal year 1988 measurable environmental results initiatives: Underground storage-tank impacts on ground water. Technical report, 14:48035 (R;US)
Preliminary assessment/site investigation: Tooele Army Depot, Utah. Volume 2. South Area. Final report, 14:48017 (R;US)
Superfund Record of Decision (EPA Region 9): MGM Brakes site, Cloverdale, California (first remedial action), September 1988. Final report, 14:48054 (R;US)
Superfund Record of Decision: (EPR Region 6): Curley Pit Site, ground-water operable unit, Crittenden County, Arkansas (second remedial action), September 1988. Final report, 14:48055 (R;US)
Water Pollution Control
Biodegradation of trichloroethylene and biomanipulation of aquifers. Technical report (Final), 14:48030 (R;US)
Water Quality
Acidification and water pathways. Vol. II, 14:48012 (R;NO)
Extent and trend of nitrate contamination in Region III: The Coastal Plain and Piedmont Province. Technical report, 14:48034 (R;US)
GROUND-WATER RESERVES
See AQUIFERS
GROUTING
INEL studies concerning solidification of low-level waste in cement, 14:46965 (R;US)
Performance assessment on grouted double-shell tank waste at Hanford, 14:46982 (R;US)
GYPSUM CEMENTS
Post-failure strength of gypsum silica-sand aggregate stemming material, 14:47885 (RA;US)
GYROCONS
Gyroklystron device having multi-slot bunching cavities, 14:47772 (P;US)
GYROTRONS
See MICROWAVE AMPLIFIERS

H

HADRON REACTIONS
Study of the optical potential for hadron-nucleus scattering using Glauber's theory, 14:48467 (R;XA)
HADRONS
Characteristics of hadron production in e^+e^- annihilation at LEP energy in the frame of the Luna Monte Carlo fragmentation model, 14:48354 (RA;SU)
Spin correlation effects in the hadroproduction and decay of very heavy top quark pairs, 14:48360 (J;US)
Spin forces in hadron spectroscopy: quark model versus electromagnetic spin interactions, 14:48333 (RA;PL)
Two-photon physics at LEP, 14:48352 (RA;SU)
Verification of high energy interaction model using data on cosmic rays in the atmosphere, 14:48177 (RA;PL)

HALL GENERATORS
See MHD GENERATORS
HALLEY COMET
P/Halley the model comet, in view of the imaging experiment aboard the VEGA spacecraft, 14:48182 (R;HU)
HALOGENATED ALIPHATIC HYDROCARBONS
Health-risk assessment of trichlorofluoromethane in California drinking water, 14:48150 (R;US)
Modified purge-and-trap/gas-chromatography method for analysis of volatile halocarbons in microbiological degradation studies (journal version), 14:48031 (R;US)
HANDLING (DATA)
See DATA PROCESSING
HANDLING (WASTES)
See WASTE MANAGEMENT
HANFORD ENGINEERING DEVELOPMENT LABORATORY
Environmental monitoring at the US Department of Energy's Hanford Site, Washington, 14:47990 (RA;US)
HANFORD RESERVATION
Hanford radiological protection support services annual report for 1988, 14:47837 (R;US)
Hanford wells, 14:48046 (R;US)
Supplemental information for a notice of construction for the Fueled Clad Fabrication System, the Radioisotope Power Systems Facility, and the Fuel Assembly Area, 14:46985 (R;US)
HARBORS
Engineering and economic analysis of containment area/wetlands disposal options in New York harbor. Final report, 14:48018 (R;US)
HARD-SPHERE MODEL
Solution of the non-linear Boltzmann equation for a homogeneous hard-sphere gas, 14:48263 (RA;AT;In German)
HAWAII
Iridium emissions from Hawaiian volcanoes, 14:48196 (RA;US)
HAZARDOUS MATERIALS
Air Pollution
Characterization of the atmospheric pathway at hazardous waste sites, 14:47921 (RA;US)
Asbestos
Superfund Record of Decision (EPA Region 2): Asbestos Dump, Millington Site, Millington, New Jersey (first remedial action), September 1988, 14:47999 (R;US)
Cadmium
Toxicological profile for cadmium. Final report, 14:48152 (R;US)
Combustion Kinetics
Kinetics of the reactions of chlorinated alkynes with atomic oxygen: The application of a new experimental technique, 14:47920 (BA;US)
Data Base Management
Toxic Release Inventory (TRI), United States and Territories, 1987 (DBASE III) (for microcomputers). Data file, 14:48115 (R;US)
Toxic Release Inventory (TRI), United States and territories, 1987 (Lotus 1-2-3) (for microcomputers). Data file, 14:48116 (R;US)
Dusts
Evaluation of dustiness test methods and recommendations for improved dust control at Heubach Inc., Newark, New Jersey. Study report, 14:47942 (R;US)
Environmental Exposure Pathway
Characterization of the atmospheric pathway at hazardous waste sites, 14:47921 (RA;US)
Environmental Impacts
Remedial investigation of the High Explosives Burn Pit facility, Building 829 complex, Lawrence Livermore National Laboratory site 300, 14:47862 (R;US)
Ground Disposal
Characterization of sediment in a leaching trench RCRA (Resource Conservation and Recovery Act) site, 14:46990 (RA;US)
Characterization of the atmospheric pathway at hazardous waste sites, 14:47921 (RA;US)
Health Hazards
A desk-top computer forecast for emergency response planning, 14:47919 (R;US)
Indoor Air Pollution
Health-hazard evaluation report HETA-87-300-0000, B. F. Goodrich Company, Marietta, Ohio, 14:47944 (R;US)
Land Pollution
Superfund Record of Decision (EPA Region 6): Sol Lynn/Industrial Transformers, Texas (first remedial action), September 1988. Final report, 14:48009 (R;US)
Lightning
Lightning safe environment for hazardous materials, 14:47221 (RA;US)
Methylene Chloride
Toxicological profile for methylene chloride. Final report, 14:48151 (R;US)
Minimization
A tracking system for hazardous waste minimization, 14:47214 (RA;US)
Occupational Exposure
Occupational hazards of laser-material processing. Final report, 1 October 1972-31 January 1975, 14:47939 (R;US)
Paints
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Remedial Action
[Air Force asbestos management program]: Foreign trip report, August 16–September 3, 1988, 14:48144 (R;US)
Risk Assessment
Risk-assessment management, communication: a guide to selected sources. Volume 2, Number 2. Information guide, 14:47230 (R;US)
Transport
Trends in state and local regulations of the transportation of hazardous and radioactive materials, 14:47009 (RA;US)
Transport Regulations
DOT/OSHA/EPA (Department of Transportation/Occupational Safety and Health Administration/Environmental Protection Agency) integrated DOE (Department of Energy) transportation training, 14:47219 (RA;US)
Waste Disposal
Soil cleanup by in situ surfactant flushing. I. Mathematical modeling and lab scale results, 14:47980 (RA;US)
Superfund Record of Decision (EPA Region 1): Groveland Wells Nos. 1 and 2 Site, Valley site source-control organic operable unit, Groveland, Massachusetts (first remedial action), September 1988, 14:48057 (R;US)
Superfund Record of Decision (EPA Region 9): MGM Brakes site, Cloverdale, California (first remedial action), September 1988. Final report, 14:48054 (R;US)
Superfund Record of Decision (EPA Region 9): Operating Industries, Inc. (OII), Monterey Park, California (third remedial action), September 1988, 14:48001 (R;US)
Superfund Record of Decision: (EPR Region 6): Curley Pit Site, ground-water operable unit, Crittenden County, Arkansas (second remedial action), September 1988. Final report, 14:48055 (R;US)
Use of quantitative risk assessment and risk management in a facility siting issue at Randolph Air Force Base, 14:47984 (RA;US)
[Preparation of a document on the subsurface disposal of liquid hazardous waste]: Foreign trip report, April 22–29, 1989, 14:46972 (R;US)
Waste Management
A tracking system for hazardous waste minimization, 14:47214 (RA;US)
Isolation and identification of microorganisms capable of degrading common laboratory solvents, 14:47224 (RA;US)
Preliminary assessment/site investigation: Tooele Army Depot, Utah. Volume 2. South Area. Final report, 14:48017 (R;US)
RCRA (Resource Conservation and Recovery Act) inspection manual. Final report, 14:47293 (R;US)
Remedial technology screening method, 14:46941 (RA;US)
The development of a hazardous waste management system in Manitoba, 14:47225 (R;CA)

Water Pollution
Superfund Record of Decision (EPA Region 6): Sol Lynn/Industrial Transformers, Texas (first remedial action), September 1988. Final report, 14:48009 (R;US)

HAZARDOUS MATERIALS SPILLS
Laboratory studies to support microbially mediated in situ soil remediation, 14:47978 (RA;US)

HCDA
See REACTOR CORE DISRUPTION

HD 8077
See NICKEL BASE ALLOYS

HEALTH HAZARDS
A review of GEOTOX for the EPA multi-media assessment project, 14:47986 (R;US)

HEALTH PHYSICS
See RADIATION PROTECTION

HEAT CAPACITY
See SPECIFIC HEAT

HEAT ENGINES
Nuclear closed-cycle gaseous heat engine concept, 14:47101 (R;US)
Proceedings of the sixth annual coal-fueled heat engines and gas stream cleanup systems contractors review meeting, 14:46879 (R;US)

HEAT EXCHANGERS
Flat plate heat exchangers for the new production reactor, 14:47122 (R;US)
Heat exchangers: a strategic analysis, 14:47281 (R;FR;In French)
PATRAN as an engineering design visualization tool: Design and analysis of a heat exchanger support, 14:47753 (R;US)
Research needs in direct-contact heat exchange, 14:47757 (BA;US)

HEAT PIPES
Design and demonstration of a high-temperature, deployable, membrane heat-pipe radiator element, 14:47752 (R;US)

HEAT STORAGE DEVICES
See THERMAL ENERGY STORAGE EQUIPMENT

HEAT STORAGE SYSTEMS
See THERMAL ENERGY STORAGE EQUIPMENT

HEAT TRANSFER
Forced convection heat transfer of interacting spheres, 14:47758 (J;US)

HEAT TRANSMISSION
See HEAT TRANSFER

HEAVY ION ACCELERATORS
Future high energy heavy ion physics at Brookhaven, 14:47789 (J;NL)

HEAVY ION REACTIONS
An overview of relativistic hydrodynamics as applied to heavy ion reactions, 14:48473 (R;US)
Report on the Oak Ridge workshop on Monte Carlo codes for relativistic heavy-ion collisions, 14:48485 (J;NL)
[Heavy ion physics]: Foreign trip report, July 17, 1988–August 4, 1988, 14:48481 (R;US)

HEAVY IONS
Heavy ion acceleration at the AGS: Present and future plans, 14:47790 (R;US)
Pre-scission particle and gamma-ray emission in heavy-ion induced fission, 14:48428 (R;AU)

HEAVY OILS
See PETROLEUM

HELIAC STELLARATORS
Multi-view scanning interferometer for the H-1 heliac, 14:48618 (RA;AU)

HELICAL INSTABILITY
Free boundary stability of helical plasmas using PEST25, 14:48633 (RA;AU)

HELIUM
19-state R-matrix calculation of the electron-photon coincidence parameters λ and —chi— for the electron excitation of $1^1s \rightarrow 3^{3,1}p$ in helium at 29.6 eV, 14:48258 (R;XA)
Continuum effects in electron-helium total cross sections, 14:48255 (R;AU)

HELIUM 3
D-^{3}He as fusion fuel, 14:48679 (RA;AT;In German)

HELIUM DILUTION REFRIGERATORS
Thermal design of a 10-kW helium refrigerator, 14:48687 (R;JP;In Japanese)

HELIUM IONS
Defects in H^+- and He^+-irradiated silicon, 14:47429 (RA;AT;In German)

HEPTANE
A detailed chemical kinetic reaction mechanism for the oxidation of iso-octane and n-heptane over an extended temperature range and its application to analysis of engine knock, 14:47619 (BA;US)
Combustion efficiency, radiation, CO and soot yield from a variety of gaseous, liquid, and solid fueled buoyant diffusion flames, 14:46902 (BA;US)
JSFR (Jet Stirred Flow Reactor) combustion processes of n-heptane and isooctane, 14:47682 (BA;US)
Observations on the low temperature vaporization and envelope or wake flame burning of n-heptane droplets at reduced gravity during parabolic flights, 14:47710 (BA;US)
Photolytic perturbation method to investigate the kinetics of hydrocarbon oxidation near 800 K, 14:47621 (BA;US)
The combustion of unsupported heptane/hexadecane mixture droplets at low gravity, 14:47711 (BA;US)

HERA STORAGE RING
Construction of a test cell for the laser calibration of the planar ZEUS drift chambers and studies of algorithms for the analysis of FADC signals, 14:47822 (R;DE;In German)
HERA: the physics and the machine, 14:48311 (RA;PL)

HERBICIDES
Epidemiologic investigation of health effects in Air Force personnel following exposure to herbicides. Summary mortality update, 1989. Interim report 1979-1987, 14:48113 (R;US)

HETEROCYCLIC COMPOUNDS
Cyclopentane formation in the reduction of 1,5-dihaloalkanes with a nickel(I) macrocycle, 14:47023 (J;US)
Photodynamics of a nickel hydrocorphinoid model of F_{430}, 14:47022 (J;US)

HEXADECANE
The combustion of unsupported heptane/hexadecane mixture droplets at low gravity, 14:47711 (BA;US)

HFETR REACTOR
Heavy isotope method for burnup determination of HFETR fuel elements, 14:47123 (RA;XA)

HFIR REACTOR
Component and system simulation models for High Flux Isotope Reactor, 14:47119 (R;US)

HIGGS BOSONS
Hermeticity requirements at SSC [Superconducting Super Collider], 14:48290 (R;US)

HIGGS MODEL
Triviality of the Higgs field, 14:48382 (J;US)

HIGH ALTITUDE (STRATOSPHERE)
See STRATOSPHERE

HIGH ENERGY PHYSICS
High energy physics: Progress report, December 1, 1988–November 30, 1989, 14:48289 (R;US)
Novel methods for reconstruction of events in experimental high-energy physics, 14:48314 (RA;AT;In German)
Physics and Monte Carlo on DELPHI, 14:48317 (RA;SU)

HIGH ENERGY RADIOTHERAPY
See RADIOTHERAPY

HIGH EXPLOSIVES
See CHEMICAL EXPLOSIVES

HIGH FLUX ISOTOPE REACTOR
See HFIR REACTOR

HIGH TEMPERATURE GAS COOLED AND GRAPHITE MODERATED REACTORS
See HTGR TYPE REACTORS

HIGH-LEVEL RADIOACTIVE WASTES
Computed and measured responses of a thick-walled hollow cylinder of salt subjected to both homogeneous and inhomogeneous loading, 14:46983 (R;US)

EQ3/6 - Status and future development, 14:46959 (RA;US)
Geologic containment of radioactive waste, 14:46969 (R;US)
Mineralogy-petrology studies and natural barriers at Yucca Mountain, Nevada, 14:46970 (R;US)
Nondestructive assay and real-time radiography requirements for remote-handled wastes at the proposed WHPP facility, 14:46937 (RA;US)
Studies on spent fuel dissolution behavior under Yucca Mountain repository conditions, 14:46980 (R;US)

HO2
See HYDROPEROXY RADICALS

HOG FUEL
See WOOD WASTES

HOLMIUM IODIDES
^{127}I NQR study of holmium iodide compounds with monovalent metals (Metals: K, Rb, Cs, Ag, Tl.), 14:47515 (RA;SU;In Russian)

HORMONES
[Studies on the mechanism of insulin control of gene expression]: Foreign trip report, July 8–19, 1988, 14:48089 (R;US)

HOSPITALS
Hospital incinerator operator training course. Volume 1. Student handbook. Final report, 14:47948 (R;US)
Hospital incinerator operator training course. Volume 2. Presentation slides. Final report, 14:47949 (R;US)

HOT CELLS
INEL [Idaho National Engineering Laboratory] hot shop contamination control during TMI-2 [Three Mile Island Unit 2] core debris handling, 14:47198 (J;US)

HOT GAS CLEANUP
Proceedings of the sixth annual coal-fueled heat engines and gas stream cleanup systems contractors review meeting, 14:46879 (R;US)
System simulation and comparison of advanced flue gas cleanup processes in coal-fired power plant using salt code, 14:47078 (R;US)
[Pittsburgh Energy Technology Center] quarterly technical progress report for the period ending June 30, 1988, 14:46791 (R;US)

HOT-DRY-ROCK SYSTEMS
Camborne geothermal energy project 2C-7 resource evaluation. V. 1. Overview, 14:47053 (R;GB)
Camborne geothermal energy project 2C-7 resource evaluation. V. 3. Gravity and thermal modelling, 14:47055 (R;GB)
Hot Dry Rock geothermal energy— A new energy agenda for the twenty-first century, 14:47056 (R;US)

HOUSES
Heat energy saving by walls with transparent thermal insulation layers - measured results in idealised boundary conditions. Interim report, 14:47269 (R;DE;In German)
The impact of performance standards on the uncertainty of the Pacific Northwest electric system: A final report on the hypersens analysis of CPAM [Conservation Policy Analysis Model], 14:47080 (R;US)
Thermal behaviour of transparent layers of insulation on building facades - comparison of measurement and calculation. Interim report, 14:47268 (R;DE;In German)

HTGR TYPE REACTORS
Safety aspects of the Modular High-Temperature Gas-Cooled Reactor (MHTGR), 14:47114 (R;US)
[High temperature fuel behavior, fission products, and graphite]: Foreign trip report, March 5–13, 1988, 14:47098 (R;US)

HUGENHOLTZ-PINES THEORY
See HYDROGEN

HUMAN CELLS
See ANIMAL CELLS

HUMAN POPULATIONS
Dosimetry studies pertaining to the accident at TMI-2 [Three Mile Island Unit 2], 14:47179 (J;US)
Exposure of the US population from occupational radiation, 14:48130 (R;US)
Measurement of radioactivity from Chernobyl in population groups in Scotland, 14:47991 (R;GB)
Radiological consequences of the Chernobyl accident in the Soviet union and measures taken to mitigate their impact, 14:47128 (R;FR;In French)
Radiological effects of Chernobyl reactor accident on the lakes of Southern Bavaria, 14:47125 (R;FR;In French)
Radiological impact of the Chernobyl reactor accident, on the countries of the European Community, 14:48124 (RA;FR)

HUMANS
See HUMAN POPULATIONS

HYDRAULIC FLUIDS
Hot-surface ignition tests of aircraft fluids. Final report, May 1987-May 1988, 14:46901 (R;US)
Superfund Record of Decision (EPA Region 9): MGM Brakes site, Cloverdale, California (first remedial action), September 1988. Final report, 14:48054 (R;US)

HYDRAULIC FRACTURES
Simultaneous modeling of dynamic ground motion and fluid flow in hydrofractures, 14:47876 (RA;US)

HYDRAULIC FRACTURING
Similarity analysis of condensing flow in a fluid driven fracture, 14:47875 (RA;US)

HYDRAZINE
Numerical simulation study of a hydrazine/nitrogen dioxide diffusion flame in a Burke-Schumann burner, 14:47696 (BA;US)

HYDROCARBONS
Chemical kinetic modeling and sensitivity analyses for boron assisted hydrocarbon combustion, 14:47622 (BA;US)
Direct measurements of methoxy removal rate constants for collisions with CH_4, Ar, N_2, Xe, and CF_4 in the temperature range 673-973 K, 14:47627 (BA;US)
Flash photolysis studies of RhCl(CO)L2 (L = trimethyl- or tritolylphosphine). Evidence for intermediates in the photocatalytic carbonylation of hydrocarbons, 14:47541 (J;US)
Oscillatory combustion in closed vessels: Theoretical foundations and their experimental verification, 14:47679 (BA;US)
Promoted high-temperature reactions, 14:47620 (BA;US)
Tabulation of rate constants for combustion modeling, 14:47624 (BA;US)

HYDROCHLORIC ACID
Pilot-scale HCl control by dry alkaline injection for emissions from refuse incinerators. Technical report, 14:47946 (R;US)
Roles of pH, titratable acid, and specific chemical composition in mediating effects of acid aerosols on the airways. Final report, 14:48147 (R;US)

HYDROGEN
Discussion of two-photon laser-excited fluorescence as a method for quantitative detection of oxygen atoms in flames, 14:47467 (BA;US)
Dynamic effects of autoignition centers for hydrogen and $C_{1,2}$-hydrocarbon fuels, 14:47686 (BA;US)
Finite chemical reaction rate and local equilibrium effects in turbulent hydrogen-air diffusion flames, 14:47594 (BA;US)
Hydrogen-assisted thermal donor formation in silicon, 14:48522 (R;US)
Market assessment for hydrogen from the catalyzed gasification of low-rank coals, 14:47076 (BA;US)
Measurements of absolute rate coefficients for the reactions of CN radicals with H_2O, H_2, and CO_2 in the temperature range $295\ K \leq T \leq 1027\ K$, 14:47637 (BA;US)
Multiphoton-excited fluorescence measurements of atomic hydrogen in low-pressure flames, 14:47660 (BA;US)
Propagation mechanism of quasi-detonations, 14:47689 (BA;US)
Rate-controlled constrained equilibrium calculation of ignition delay times in hydrogen-oxygen mixtures, 14:47688 (BA;US)
The influence of turbulence on the burning velocity of premixed CH_4-H_2 flames with different laminar burning velocities, 14:47604 (BA;US)
The reactions of benzyl radicals with hydrogen atoms, oxygen atoms, and molecular oxygen using EI/REMPI mass spectrometry, 14:47632 (BA;US)
The structures of fast deflagrations and quasi-detonations, 14:47690 (BA;US)
Uncertainties in hydrogen combustion for nuclear reactor safety, 14:47151 (R;US)

Understanding complex chemical kinetics with computational singular perturbation, 14:47623 (BA;US)

HYDROGEN 2
See DEUTERIUM

HYDROGEN 3
See TRITIUM

HYDROGEN CHLORIDES
See HYDROCHLORIC ACID

HYDROGEN DONOR REACTIONS
See HYDROGEN TRANSFER

HYDROGEN FUEL CELLS
Cryogenic reactant storage for lunar base regenerative fuel cells, 14:47203 (R;US)
Mars manned transportation vehicle, 14:47263 (R;US)

HYDROGEN GENERATORS
Long-endurance underwater power system. Quarterly report, January-March 1989, 14:47260 (R;US)

HYDROGEN HYDROXIDES
See WATER

HYDROGEN IONS
Defects in H^+- and He^+-irradiated silicon, 14:47429 (RA;AT;In German)

HYDROGEN ISOTOPES
Development and application of stable isotope mass transfer reaction path models, 14:47058 (RA;US)

HYDROGEN NITRATES
See NITRIC ACID

HYDROGEN SULFATES
See SULFURIC ACID

HYDROGEN TRANSFER
Donor hydrogen depletion in coal liquefaction, 14:46793 (R;US)

HYDROPEROXY RADICALS
Reactions of HO_2 radicals in combustion chemistry, 14:47618 (BA;US)

HYDROSPHERE
Computer modeling of the aqueous geochemistry of the Archean hydrosphere and the formation of banded iron formations, 14:48169 (RA;US)

HYDROTHERMAL CONVECTIVE SYSTEMS
See HYDROTHERMAL SYSTEMS

HYDROTHERMAL SYSTEMS
Application of EQ3/6 to modeling the chemical evolution in hydrothermal systems: An example at the Valles Caldera, N.M., 14:47062 (RA;US)
Application of the quasi-stationary state approximation to interpret water-rock interactions in open hydrothermal systems, 14:46981 (R;US)
Preliminary chemical modeling of epithermal processes at Creede, Colorado: The role of fluid mixing as an ore deposition mechanism, 14:47059 (RA;US)
Progressive mineral alteration and coupled ^{18}O depletions in the Lake City hydrothermal system (23 Ma), Colorado, 14:47061 (RA;US)

HYDROXY COMPOUNDS
The burning rate of hydroxylammonium nitrate-based liquid propellants, 14:47698 (BA;US)

HYDROXYL RADICALS
A theoretical analysis of the reaction between hydroxyl and acetylene, 14:47631 (BA;US)
Fluorescence studies of OH and CN radicals in atmospheric pressure flames using picosecond excitation, 14:47661 (BA;US)
Laser photolysis shock tube for combustion kinetics studies, 14:47538 (BA;US)
The quantitative LIF (laser-induced fluorescence) determination of OH concentrations in low-pressure flames, 14:47465 (BA;US)
Theoretical study of the reactions rates of $OH + OH \Longleftrightarrow H_2O + O$, 14:47628 (BA;US)

HYPERFRAGMENTS
See HYPERNUCLEI

HYPERNUCLEI
Electromagnetic production of hypernuclei, 14:48322 (J;US)

I

I-BEAM TYPE REACTORS
See ION BEAM FUSION REACTORS

ICE
[Meeting of the Society for Cryobiology]: Foreign trip report, July 8–27, 1988, 14:48097 (R;US)

ICF DEVICES
Pulsed-power switching for inertial confinement fusion with light ion beams, 14:48692 (R;US)

ICR HEATING
High power ion cyclotron resonance in JET: the JET radio frequency division and the JET team, 14:48609 (RA;AU)

IDAHO NATIONAL ENGINEERING LABORATORY
Corrective action investigation of a mixed waste contaminated percolation pond, 14:47003 (R;US)
INEL [Idaho National Engineering Laboratory] hot shop contamination control during TMI-2 [Three Mile Island Unit 2] core debris handling, 14:47198 (J;US)
Management program for underground storage tanks at the Idaho National Engineering Laboratory, 14:47779 (RA;US)

ILLINOIS
Toxic chemical report, first annual: a summary of information contained in the toxic chemical report forms for calendar year 1987. Final report, 14:47226 (R;US)

ILLUMINANCE
Evaluating office lighting environments: Second-level analysis, 14:47273 (R;US)

ILLUMINATION
See ILLUMINANCE

ILLUMINATION SYSTEMS
See LIGHTING SYSTEMS

IMAGE PROCESSING
PACS image archiving and -communication in radiology, 14:48104 (RA;AT;In German)
Video imaging systems: A survey, 14:47848 (R;US)

IMPACT SHOCK
Geological remote sensing signatures of terrestrial impact craters, 14:48197 (RA;US)

IMPERMEABLE DRY ROCK
See HOT-DRY-ROCK SYSTEMS

IMPULSE
See PULSES

IMPURITIES
Thermospray liquid-chromatography mass spectrometry of thiol radioprotective agents: Characteristics spectra. Scientific report, 14:48119 (R;US)

IN-CORE FUEL MANAGEMENT
See FUEL MANAGEMENT

INCINERATION
See COMBUSTION

INCINERATORS
Baghouse efficiency on a multiple-hearth incinerator burning sewage sludge, 14:47950 (R;US)
Hospital incinerator operator training course. Volume 1. Student handbook. Final report, 14:47948 (R;US)
Hospital incinerator operator training course. Volume 2. Presentation slides. Final report, 14:47949 (R;US)
Locating and estimating air-toxics emissions from municipal-waste combustors. Final report, August 1988-March 1989, 14:47955 (R;US)
Pilot-scale HCl control by dry alkaline injection for emissions from refuse incinerators. Technical report, 14:47946 (R;US)
Resonantly enhanced multiphoton ionization for the trace detection of chlorinated aromatics, 14:47463 (BA;US)

INCONEL 617
Threshold for fatigue crack propagation, 14:47348 (R;DE;In German)

INCONEL ALLOYS
Polishing methods for metallic and ceramic transmission electron microscopy specimens: Revision 1, 14:47329 (R;US)

INDIA
[Coal conversion, renewable energy and energy efficiency in India]: Foreign trip report, October 31, 1988–December 8, 1988, 14:46882 (R;US)
[Fluidized bed combustion of high-ash Indian coals]: Foreign trip report, January 5, 1988–March 16, 1988, 14:46881 (R;US)

INDIAN RESERVATIONS
EPA's (Environmental Protection Agency) role in non-hazardous solid-waste management on Indian land: Issues and options. Technical report, 14:47231 (R;US)
Guidelines and requirements for applying for grants from the Indian set-aside program, 14:48073 (R;US)

INDIUM ANTIMONIDES
Energy relaxation of light holes in $InAs_{.15}Sb_{.85}$/InSb multiple quantum wells, 14:48523 (R;US)

INDIUM ARSENIDES
Investigations of the quantum photovoltaic effect in InAs-GaSb semiconductor superlattices, 14:47413 (R;US)
MeV implantation studies in LPE (liquid phase epitaxy)-grown GaAs and InP. Final report, 1 October 1987-31 March 1989, 14:47411 (R;US)
Strain and density dependent valence-band masses in InGaAs/GaAs and GaAs/GaAsP strained-layer structures, 14:47447 (R;US)

INDIUM COMPOUNDS
NMR, XES, and IR-spectroscopy study of complexing ability of phosphorus-containing ionites (Indium ion sorption.), 14:47503 (RA;SU;In Russian)

INDOOR AIR POLLUTION
Central radon data base and digitized bedrock map of US EPA (Environmental Protection Agency) Region 1. Technical report, 14:47964 (R;US)
Communicating radon risk effectively: Radon testing in Maryland. Final report, 14:47965 (R;US)
Diagnostic approaches to better solutions of radon IAQ (indoor air quality) problems, 14:47962 (R;US)
Evaluation of dustiness test methods and recommendations for improved dust control at Heubach Inc., Newark, New Jersey. Study report, 14:47942 (R;US)
Federal policy options for indoor air pollution from combustion appliances. Technical report, 14:47968 (R;US)
Radon measurements in schools: an interim report, 14:47963 (R;US)
Topical report on a field-monitoring study of homes with unvented gas space heaters. Volume 4. Quality assurance/control procedures and results. Final report, January 1985-June 1987, 14:47952 (R;US)

INDUSTRIAL WASTES
Application of minimization techniques to metal preparation and finishing operations in the Air Training Command, 14:47216 (RA;US)
Best demonstrated available technology (BDAT) background document for K046 nonreactive subcategory. Final report, 14:47291 (R;US)
Best demonstrated available technology (BDAT) background document for K101 and K102: Low arsenic subcategory. Final report, 14:47292 (R;US)
Best demonstrated available technology (BDAT) background document for K103 and K104. Final report, 14:47290 (R;US)
Multi-media compliance audit procedures, 1989. Final report, 14:47232 (R;US)
Summary of findings on evaluation of aqueous degreasers versus chlorinated solvents at the Paducah Gaseous Diffusion Plant, 14:46940 (RA;US)
Superfund Record of Decision (EPA Region 1): Rose Disposal Pit, Lanesborough, Massachusetts (first remedial action) September 1988. Final report, 14:48005 (R;US)
Superfund Record of Decision (EPA Region 2): Ewan Property, Burlington County, New Jersey (first remedial action), September 1988, 14:48004 (R;US)
Superfund Record of Decision (EPA Region 3): Drake Chemical Site, Lock Haven, Pennsylvania (third remedial action), September 1988. Final report, 14:48079 (R;US)
Superfund Record of Decision (EPA Region 4): Celanese Fibers Operations, Shelby, North Sarolina (first remedial action), March 1988, 14:48078 (R;US)
Superfund Record of Decision (EPA Region 4): Flowood, Rankin County, Mississippi (first remedial action), September 1988. Final report, 14:48077 (R;US)
Superfund Record of Decision (EPA Region 5): Kummer Sanitary Landfill, Beltrami County, Minnesota (second remedial action) September 1988, 14:48006 (R;US)
Superfund Record of Decision (EPA Region 5): Velsicol Chemical Corporation, Marshall, Illinois (first remedial action), September 1988. Final report, 14:48076 (R;US)
Superfund Record of Decision (EPA Region 6): Sol Lynn/Industrial Transformers, Texas (first remedial action), September 1988. Final report, 14:48009 (R;US)
Water-pollution abatement expenditures in the Wisconsin paper industry. Technical report, 14:48037 (R;US)

INERTIAL CONFINEMENT
Past two years of laser fusion, 14:48683 (RA;AU)

INERTIAL CONFINEMENT FUSION DEVICES
See ICF DEVICES

INFORMATION DISSEMINATION
Laboratory for Computer Science progress report 24, July 1986-June 1987, 14:48716 (R;US)

INFORMATION SYSTEMS
Evaluation of an 1840A magnetic tape from Interleaf, Incorporated, 14:48707 (R;US)
Publishing systems structured Test No. 1: Summary report, 14:48750 (R;US)
TOXLEARN: Microcomputer-based training for TOXLINE. Software, 14:48114 (R;US)

INFRARED SPECTRA
Far infrared spectroscopy on high temperature superconductors. $YBa_2Cu_{3-x}Zn_xO_{7-y}$, 14:47427 (RA;AT;In German)

INFRARED SPECTROMETERS
Application of FT-IR emission/transmission (E/T) spectroscopy to study coal combustion phenomena, 14:46863 (BA;US)

INHALATION EXPOSURE CHAMBERS
See EXPOSURE CHAMBERS

INHOMOGENEOUS PLASMA
Effect of small-scale inhomogeneities on the properties of waves in plasmas, 14:48641 (RA;AU)

INJECTION (BEAMS)
See BEAM INJECTION

INKS
Health-hazard evaluation report HETA-87-300-0000, B. F. Goodrich Company, Marietta, Ohio, 14:47944 (R;US)

INLAND WATERWAYS
Acidification and water pathways. Vol. II, 14:48012 (R;NO)

INORGANIC COMPOUNDS
Estimated low-range costs for the removal of inorganics, radionuclides, and corrosion-related contaminants from potable water supplies (draft), January 1987, 14:48039 (R;US)
Information-collection request for: National Primary Drinking Water Regulations for inorganic chemicals. Phase 2, March 1989, 14:48071 (R;US)
Regulatory impact analysis of proposed National Primary Drinking Water Regulations for synthetic organic chemicals. Phase 2, April 1989, 14:48070 (R;US)
Regulatory impact analysis: Benefits and costs of proposed National Primary Drinking Water Regulations for inorganic chemicals. Phase 2, March 1989, 14:48069 (R;US)

INSTRUMENTS (MEASURING)
See MEASURING INSTRUMENTS

INSULATORS (ELECTRICAL)
See ELECTRICAL INSULATORS

INSULIN
[Studies on the mechanism of insulin control of gene expression]: Foreign trip report, July 8–19, 1988, 14:48089 (R;US)

INTEGRAL EQUATIONS
Approximation method for nonlinear integral equations of Hammerstein type, 14:48548 (R;XA)

INTERACTIVE DISPLAY DEVICES
Design criteria and realization of a computerized supervisory system for nuclear applications, 14:47110 (R;IT)
TIKTEK: A Tektronix emulator based on 2D GMR, 14:48728 (R;US)
INTERACTIVE GRAPHICS
See INTERACTIVE DISPLAY DEVICES
INTERFACES
[The theory of ac impedance of rough electrode-electrolyte interfaces]: Foreign trip report, May 19, 1989–June 5, 1989, 14:47534 (R;US)
INTERFEROMETRY
Application of two-component phase Doppler interferometry to the measurement of particle size, mass flux, and velocities in two-phase flows, 14:47469 (BA;US)
Zeeman interferometry, 14:48271 (R;US)
INTERLOCKS
Room clearance and radiation safety interlock system for neutron therapy treatment room, 14:48111 (R;ZA)
INTERMEDIATE BOSONS
Possibility of studying the vertex W-γW in the process $e^+e^- \rightarrow \gamma\nu\nu$-bar, 14:48349 (RA;SU)
INTERMEDIATE VECTOR BOSONS
Observation of $W \rightarrow \mu\nu$ decays in proton-antiproton collisions at $\sqrt{s}$ = 1.8 TeV, 14:48296 (R;US)
INTERMETALLIC COMPOUNDS
Calorimetric and magnetic properties in uranium -intermetallic compounds, 14:47353 (RA;AT;In German)
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INTERNAL COMBUSTION ENGINES
Comparison of computed and measured air motion in circular and square piston cups, 14:47311 (B;US)
Dedicated low-pressure natural gas-fueled vehicle baseline assessment. Task 3 topical report on light-duty vehicles. Topical report, January 1987-January 1989, 14:47318 (R;US)
Emissions data for stationary reciprocating natural gas engines and gas turbines in use by the gas-pipeline-transmission industry (for microcomputers). Data file, 14:46912 (R;US)
Engine combustion optimization by exhaust analysis. Final report, December 1986-July 1988, 14:47307 (R;US)
Imaging of engine flow and combustion processes, 14:47309 (B;US)
INTRANUCLEAR CASCADES
See NUCLEAR CASCADES
INVERSE SCATTERING PROBLEM
Novel methods for treating the inverse scattering problem, 14:48568 (RA;AT;In German)
INVERTEBRATES
Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest): Pile perch, striped seaperch, and rubberlip seaperch, 14:48016 (R;US)
IODATES
^{81}Br, ^{127}I NQR study of $AgBrO_3$, $AgIO_3$, Ag_2HgI_4, 14:47501 (RA;SU;In Russian)
IODIDES
^{81}Br, ^{127}I NQR study of $AgBrO_3$, $AgIO_3$, Ag_2HgI_4, 14:47501 (RA;SU;In Russian)
IODINE
Orbital momentum distributions and binding energies for the complete valence shell of molecular iodine, 14:48254 (R;AU)
[Nuclear reactor severe accident chemistry]: Foreign trip report, June 1–9, 1988, 14:47115 (R;US)
IODINE 129
Measurement methods for low-level ^{129}I determinations, 14:46979 (R;US)
IODINE 131
Thyroid dose from ^{131} iodine of the population in Poland following the Chernobyl accident, 14:47129 (R;FR;In French)
IODINE BROMIDES
Structure-property relationships as an aid in the rational design of β-$(ET)_2X$ organic superconductors, 14:47347 (R;US)
IODINE IODIDES
See IODINE
ION ACOUSTIC WAVES
Ion-sound emission by Langmuir soliton crossing density barrier, 14:48586 (R;XA)
ION BEAM FUSION REACTORS
Generation and focusing of pulsed intense ion beams: Final report, 1 July 1987–30 September 1988, 14:48671 (R;US)
ION BEAM TYPE REACTORS
See ION BEAM FUSION REACTORS
ION BEAMS
Generation and focusing of pulsed intense ion beams: Final report, 1 July 1987–30 September 1988, 14:48671 (R;US)
ION BLOCKING
See ION CHANNELING
ION CHANNELING
[Atomic physics with large electrostatic accelerators]: Foreign trip report, May 14, 1989–June 9, 1989, 14:48520 (R;US)
ION CLUSTERS
See ION PAIRS
ION COLLISIONS
Chemical effects of Ne(+) bombardment on the MoS_2(0001) surface studied by high-resolution photoelectron spectroscopy. Technical report, 14:48495 (R;US)
Studies on ions and neutrals desorbed from solid surfaces by ion and electron bombardment. Final report, 1 November 1984-31 October 1988, 14:48494 (R;US)
ION CYCLOTRON-RESONANCE HEATING
See ICR HEATING
ION EXCHANGE MEMBRANES
See MEMBRANES
ION IMPLANTATION
RF generated plasmas for plasma immersion ion implantation, 14:48624 (RA;AU)
ION PAIRS
Electron density fluctuations induced by ion clusters in condensed matter, 14:48527 (J;NL)
ION SOURCES
Extraction induced emittance growth for negative ion sources, 14:48668 (R;US)
Simulation of the low earth orbital atomic oxygen interaction with materials by means of an oxygen ion beam, 14:47439 (R;US)
The University of Washington polarized ion source, 14:47805 (R;US)
[Physics of multicharged ions]: Foreign trip report, September 12–23, 1988, 14:48276 (R;US)
ION SPECTROSCOPY
Profiles of HCO and CH_3 in CH_4/O_2 and C_2H_4/O_2 flames by resonance ionization, 14:47462 (BA;US)
ION TEMPERATURE
Spectroscopic measurement of ion and atom temperatures in a metal vapour vacuum arc, 14:48269 (RA;AU)
ION-ATOM COLLISIONS
Charge state dependence of K X-ray production in thin targets by multicharged silicon ions, 14:48281 (J;NL)
[Physics of multicharged ions]: Foreign trip report, September 12–23, 1988, 14:48276 (R;US)
ION-DRAG ACCELERATORS
See ELECTRON-RING ACCELERATORS
ION-MOLECULE COLLISIONS
Low-energy atomic collisions. Final scientific report, 1 June-30 September 1980, 14:48243 (R;US)
IONIC REACTIONS
See CHEMICAL REACTIONS
IONS
IONIZATION
Vibrational and penning-type influences of impurities on excitation and ionization in nitrogen, 14:48267 (RA;AU)
IONIZATION CALORIMETERS
See SHOWER COUNTERS
IONOSPHERE
Estimation of ionospheric electrodynamic parameters using ionospheric conductance deduced from bremsstrahlung x-ray image data. Technical report, 14:48234 (R;US)

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Origin of density enhancements in the winter polar-cap ionosphere, 14:48233 (R;US)

IONS
LISA, a time-of-flight spectrometer for measurements of stopping cross sections, 14:47828 (RA;AT;In German)
Stopping cross section for fast ions, 14:48265 (RA;AT;In German)
Studies on ions and neutrals desorbed from solid surfaces by ion and electron bombardment. Final report, 1 November 1984-31 October 1988, 14:48494 (R;US)

IONS (ATOMIC)
See ATOMIC IONS

IONS (MOLECULAR)
See MOLECULAR IONS

IRON
Creep of bcc-alloys based on Fe under conditions of cyclic irradiation, 14:47365 (RA;SU;In Russian)
High pressure studies of planetary matter, 14:48227 (R;US)
Microbial dissolution of toxic metals from coal residues, 14:46839 (RA;US)
The HEL [Hugoniot Elastic Limit] and rate-dependent yield behavior, 14:47370 (R;US)

IRON 57
Demonstration of the feasibility of the tuning and stimulation of nuclear radiation. Final report, 1 July 1981-31 October 1988, 14:48445 (R;US)

IRON ALLOYS
Liquid Dynamic Campaction of Fe-Nd-B permanent magnets. Final report, 1 September 1984-31 December 1988, 14:47327 (R;US)
Unstable magnetic order in intermetallic compounds, 14:47356 (RA;AT;In German)

IRON BASE ALLOYS
Creep of bcc-alloys based on Fe under conditions of cyclic irradiation, 14:47365 (RA;SU;In Russian)
Polishing methods for metallic and ceramic transmission electron microscopy specimens: Revision 1, 14:47329 (R;US)

IRON COMPLEXES
Pressure-induced spin-state interconversion of (Fe(6-Me-py)$_3$tren)(ClO_4)$_2$ in solution, 14:47527 (J;US)

IRON METEORITES
An atom probe study of phase decomposition in three iron meteorites, 14:48176 (R;US)

IRON OXIDES
Phase I, Volume I, Program summary and PDU [process development unit] operations: Topical report, October 1987–January 1989, 14:46816 (R;US)

IRON-ALPHA
Study of near-to-surface layers of α-Fe foil after Fe^{4+} ions irradiation and isochronous annealing, 14:47363 (RA;SU;In Russian)

IRRADIATION DEVICES
In-pile loop OWL-2 and irradiation tests done with it, 14:47118 (R;JP;In Japanese)

IRRADIATION PLANTS
Reconstruction of Co-60 Irradiation Facility No.1, 14:47015 (R;JP;In Japanese)

IRRADIATION PROCEDURES
Irradiation planning by video digitalization, 14:48103 (RA;AT;In German)

IRRADIATION RIGS
See IRRADIATION DEVICES

ISING MODEL
Microcanonical Monte Carlo, 14:48579 (BA;US)

ISLAMABAD REACTOR PAKISTAN
See PARR REACTOR

ISOBARIC SPIN
See ISOSPIN

ISOCYANIC ACID
Free-radical oxidation of isocyanic acid, 14:47638 (BA;US)

ISOSPIN
Eoet-Wash constraints on multiple Yukawa interactions and on a coupling to "isospin", 14:48437 (R;US)

ISOTOPE APPLICATIONS
Scottish Universities Research and Reactor Centre annual report 1987-1988, 14:47013 (R;GB)

ISOTOPE ENRICHED MATERIALS
REIMIEP 1987: an interlaboratory U-235 enrichment determination by gamma measurement on solid UF6 sample, 14:46927 (R;IT)

ISOTOPE SEPARATION PLANTS
Experience of TSTA milestone runs with 100 grams-level of tritium, 14:47166 (J;US)

ISOTOPES
Measurement of activation cross sections, 14:48433 (R;JP;In Japanese)

ISOTOPIC SPIN
See ISOSPIN

ITALIAN TRIGA-MARK-II REACTOR
See TRIGA-2-ROME REACTOR

ITER TOKAMAK
Projections for a steady-state tokamak reactor based on ITER, 14:48693 (R;US)
The International Thermonuclear Experimental Reactor (ITER): Design and materials selection, 14:48695 (R;US)

ITERATIVE METHODS
Application of the generalized newton-raphson method to the singly-ionized calcium line formation problem in model stellar atmospheres. Doctoral thesis, 14:48220 (R;US)

J

JABILUKA DEPOSIT
Jabiluka gold-uranium project, 14:46926 (R;AU)

JAPAN
Research and development in biotechnology-related industries in Japan (1989), 14:48092 (R;US)

JAPAN MATERIALS TESTING REACTOR
See JMTR REACTOR

JET ENGINE FUELS
Fuel-rich catalytic combustion of Jet-A fuel-equivalence ratios 5.0 to 8.0, 14:46903 (R;US)
Hot-surface ignition tests of aircraft fluids. Final report, May 1987-May 1988, 14:46901 (R;US)
Laboratory studies to support microbially mediated in situ soil remediation, 14:47978 (RA;US)

JETS
Equilibrium computations of multiphase nonideal electrolytic systems and structure of turbulent reacting dissolving jets, 14:47601 (BA;US)

JFT-2M TOKAMAK
Experimental observation of ion Bernstein wave heating on JFT-2M tokamak, 14:48653 (R;JP)

JIPPT-2 DEVICE
Development of the monitoring system for the JIPPT-IIU operation, 14:48685 (R;JP;In Japanese)
Limiter H-modes in the JIPP T-IIU tokamak, 14:48650 (R;JP)
Z_{eff} measurements and low-Z impurity transport for NBI and ICRF heated plasma in JIPP T-IIU tokamak, 14:48648 (R;JP)

JMTR REACTOR
In-pile loop OWL-2 and irradiation tests done with it, 14:47118 (R;JP;In Japanese)

JT-60 REACTORS
See JT-60 TOKAMAK

JT-60 TOKAMAK
Confinement properties of pellet injected JT-60 plasmas, 14:48654 (R;JP)

JUPITER PLANET
Jupiter Torus as a plasma and electromagnetic waveguide, 14:48180 (RA;AU)

K

KALUZA-KLEIN THEORY
Magnetic monopoles in Kaluza-Klein theory, 14:48403 (RA;PL)

KAON PLUS REACTIONS
Electromagnetic production of hypernuclei, 14:48322 (J;US)
KAONS
Status of the $\Delta I = 1/2$ rule in Kaon decay, 14:48381 (J;US)
KAPPA-725 RESONANCES
See MESONS
KEK INTERS. STORAGE ACCELERATOR
See TRISTAN STORAGE RINGS
KEK PHOTON FACTORY
Photon Factory activity report, 1988, 14:48711 (R;JP)
KERNELS (FUEL)
See FUEL PARTICLES
KEROSENE
On the flame structure at the base of a pool fire, 14:47650 (BA;US)
Spray-swirl interaction and early pyrolysis of kerosene and light oils spray flames produced by simplex pressure atomizer, 14:47707 (BA;US)
KETONES
Health-hazard evaluation report HETA-87-300-0000, B. F. Goodrich Company, Marietta, Ohio, 14:47944 (R;US)
KICKER MAGNETS
Test fast kicker pulser, 14:47802 (R;US)
KIDNEYS
Relationship between kidney burden and radiation dose from chronic ingestion of U: Implications for radiation standards for the public, 14:48139 (J;US)
KINETIC EQUATIONS
Kinetic boundary layer on a sphere and the growth of droplets, 14:48262 (RA;AT;In German)
KLYSTRONS
Gyroklystron device having multi-slot bunching cavities, 14:47772 (P;US)
KNOCK-ON ELECTRONS
See ELECTRONS
KRIGING
Regional analysis of wet deposition for effects research. Project report, 14:47936 (R;US)
KRYPTON
Breathing on the Mesa, 14:47903 (RA;US)
KUR REACTOR
Records of radiation control division, 24 (1987), 14:48493 (R;JP;In Japanese)
KYOTO UNIVERSITY REACTOR
See KUR REACTOR

L

LA REINA REACTOR
See RESEARCH REACTORS
LABELLED COMPOUNDS
Preparation of radioactive labelled compounds Pt.1. ^{82}Br labelled organic bromine compounds, 14:47545 (R;FR;In French)
Preparation of radioactive labelled compounds. Pt. 2. ^{82}Br labelled organic bromine compounds by isotopic exchange, 14:47546 (R;FR;In French)
Target-specific binding of immunoliposomes in vivo, 14:48101 (R;US)
LAKES
Charles River lower basin artificial destratification project. Final report, 14:48033 (R;US)
Massachusetts lake classification program (revised). Final report, 14:48053 (R;US)
Radiological effects of Chernobyl reactor accident on the lakes of Southern Bavaria, 14:47125 (R;FR;In French)
LAMBDA NEUTRAL
See LAMBDA PARTICLES
LAMBDA PARTICLES
Electromagnetic production of hypernuclei, 14:48322 (J;US)
LAND FILLS
See SANITARY LANDFILLS
LAND POLLUTION
Chemical Analysis
Evaluation of high-resolution gas for the determination of 2, 3, 7, 8-TCDD in soil, sediment and water (journal version), 14:47479 (R;US)

Remedial Action
Superfund Record of Decision (EPA Region 1): Landfill and Resource Recovery, Rhode Island (first remedial action), September 1988. Final report, 14:48007 (R;US)
Superfund Record of Decision (EPA Region 1): Old Springfield Landfill, Vermont (first remedial action), September 1988, 14:48080 (R;US)
Superfund Record of Decision (EPA Region 1): Rose Disposal Pit, Lanesborough, Massachusetts (first remedial action) September 1988. Final report, 14:48005 (R;US)
Superfund Record of Decision (EPA Region 2): Asbestos Dump, Millington Site, Millington, New Jersey (first remedial action), September 1988, 14:47999 (R;US)
Superfund Record of Decision (EPA Region 2): Ewan Property, Burlington County, New Jersey (first remedial action), September 1988, 14:48004 (R;US)
Superfund Record of Decision (EPA Region 3): Dorney Road Landfill Superfund Site, Lehigh County, Pennsylvania (first remedial action), September 1988, 14:48002 (R;US)
Superfund Record of Decision (EPA Region 3): Drake Chemical Site, Lock Haven, Pennsylvania (third remedial action), September 1988. Final report, 14:48079 (R;US)
Superfund Record of Decision (EPA Region 3): Palmerton Zinc Pile, Pennsylvania (second remedial action), September 1988, 14:47970 (R;US)
Superfund Record of Decision (EPA Region 3): Wildcat Landfill, Kent County, Delaware (first remedial action), June 1988, 14:48003 (R;US)
Superfund Record of Decision (EPA Region 4): Celanese Fibers Operations, Shelby, North Sarolina (first remedial action), March 1988, 14:48078 (R;US)
Superfund Record of Decision (EPA Region 4): Flowood, Rankin County, Mississippi (first remedial action), September 1988. Final report, 14:48077 (R;US)
Superfund Record of Decision (EPA Region 5): Kummer Sanitary Landfill, Beltrami County, Minnesota (second remedial action) September 1988, 14:48006 (R;US)
Superfund Record of Decision (EPA Region 5): Republic Steel Quarry Site, Elyria, Ohio (first remedial action), September 1988. Final report, 14:48075 (R;US)
Superfund Record of Decision (EPA Region 5): Velsicol Chemical Corporation, Marshall, Illinois (first remedial action), September 1988. Final report, 14:48076 (R;US)
Superfund Record of Decision (EPA Region 6): French Limited, Texas (first remedial action), March 1988. Final report, 14:48008 (R;US)
Superfund Record of Decision (EPA Region 6): Sol Lynn/Industrial Transformers, Texas (first remedial action), September 1988. Final report, 14:48009 (R;US)
Superfund Record of Decision (EPA Region 7): Shenandoah Stables, Missouri (first remedial action), July 1988, 14:48010 (R;US)
Superfund Record of Decision (EPA Region 9): MGM Brakes site, Cloverdale, California (first remedial action), September 1988. Final report, 14:48054 (R;US)
Superfund Record of Decision (EPA Region 9): Operating Industries, Inc. (OII), Monterey Park, California (third remedial action), September 1988, 14:48001 (R;US)
Superfund Record of Decision (EPA Region 9): South Bay Asbestos Area, California (first remedial action), September 1988. Final report, 14:48011 (R;US)
Superfund Record of Decision: (EPR Region 6): Curley Pit Site, ground-water operable unit, Crittenden County, Arkansas (second remedial action), September 1988. Final report, 14:48055 (R;US)

LAND POLLUTION CONTROL
Water-Waste-Soil Project: 1st Report on the status colloquium, 14:48021 (R;DE;In German)

LANDFILLS
See SANITARY LANDFILLS
LANGMUIR OSCILLATIONS
See PLASMA WAVES
LANGUAGES (PROGRAMMING)
See PROGRAMMING LANGUAGES
LANTHANUM
Partial oxidation reactions of methane and oxygen, 14:47018 (R;US)
LANTHANUM CHROMITES
See CHROMIUM OXIDES
LANTHANUM OXIDES
LANTHANUM COMPOUNDS
Preparation and properties of La(2-x)AxCuO(4-y) where A = Pb,Cd. Technical report, 14:47387 (R;US)
LANTHANUM OXIDES
Optical properties of superconducting metal oxide ceramics, 14:47394 (RA;SU;In Russian)
LASER MATERIALS
Occupational hazards of laser-material processing. Final report, 1 October 1972-31 January 1975, 14:47939 (R;US)
LASER RADIATION
Analysis and evaluation of technical data on the photochromic and nonlinear optical properties of materials. Quarterly technical report No. 1, 14:48158 (R;US)
LASER TARGETS
Interferometry and high speed photography of laser-driven flyer plates, 14:47846 (R;US)
LASER WEAPONS
Comparison of laser and neutral particle beam discrimination, 14:48752 (R;US)
LASER WELDING
Thermocapillary flow in a pulsed-laser weld pool, 14:47382 (BA;US)
LASER-PRODUCED PLASMA
Phase-modulation and the fundamental and second harmonic emission spectra from laser-produced plasmas, 14:48608 (RA;AU)
LASER-RADIATION HEATING
Comparison of multi- and single-mode C.W. laser-induced perturbations of the 1S5 states in neon, 14:48600 (RA;AU)
LASERS
Nonlinear dynamics of broad-band lasers: Progress report, September 1, 1988–August 31, 1989, 14:47741 (R;US)
The Los Alamos bright sources: Review of the physics and the diagnostic technology, 14:48273 (R;US)
Unlimited acceleration of particles by a system of multi-laser beams, 14:48684 (R;JP)
LATENT HEAT STORAGE
Modelization and identification of a latent heat buffer storage for its real time control, 14:47050 (R;FR;In French)
LATTICE FIELD THEORY
Regular lattices as saddle-points of a two dimensional random lattice theory, 14:48400 (RA;PL)
LATTICES (CRYSTAL)
See CRYSTAL LATTICES
LAUE-BRAGG SCATTERING
See BRAGG REFLECTION
LAVA
Relationship between large-hole drilling rates and compressive strength of NTS rock types, 14:47896 (RA;US)
LAWRENCE LIVERMORE LABORATORY
Nuclear Test-Experimental Science: Annual report, fiscal year 1988, 14:47245 (R;US)
LEAD
Decontamination and coating of lead, 14:46955 (RA;US)
Measurement of total neutron cross-sections for determination of the electric polarizability of the neutron, 14:48315 (RA;AT;In German)
Microbial dissolution of toxic metals from coal residues, 14:46839 (RA;US)
LEAD 208
Measurement of total neutron cross-sections for determination of the electric polarizability of the neutron, 14:48315 (RA;AT;In German)
[Coulomb excitation with fast high Z ions: Gamma-gamma coincidence study of the IVGQR and the two-phonon giant resonance states in ^{208}Pb]: Foreign trip report, April 14–19, 1989, 14:48459 (R;US)
LEAD 208 TARGET
Excitation and decay of giant multipole resonances in intermediate energy heavy ion reactions, 14:48457 (R;US)
Some TPC measurements in an oxygen beam at the AGS, 14:47839 (J;NL)
LEAD COMPOUNDS
Preparation and properties of La(2-x)AxCuO(4-y) where A = Pb,Cd. Technical report, 14:47387 (R;US)
LEAD IODIDES
^{79,81}Br, ^{127}I NQR study of Tl-containing inorganic compounds, 14:47502 (RA;SU;In Russian)
LEAD SILICATES
Investigation of erbium containing glass structure by EPR method, 14:48510 (RA;SU;In Russian)
LEAKAGE
See LEAKS
LEAKS
Remote leak detection for the Compact Ignition Tokamak, 14:48705 (J;US)
LEE MODEL
Triviality of the Higgs field, 14:48382 (J;US)
LEP STORAGE RINGS
Report on the start-up of LEP, 14:47816 (RA;AT;In German)
LEPTON-DEUTERON INTERACTIONS
See DEUTERIUM TARGET
LIGHT NUCLEI
Low-energy pion double charge exchange and nucleon-nucleon correlations in nuclei, 14:48475 (R;US)
LIGHT SCATTERING
Analysis of diesel sprays through two-dimensional laser light scattering, 14:47470 (BA;US)
LIGHTING SYSTEMS
Evaluating office lighting environments: Second-level analysis, 14:47273 (R;US)
LIGHTNING ARRESTERS
Performance of transient limiters under laboratory, simulated, and rocket-triggered lightning conditions, 14:47769 (R;US)
LIGNITE
A study of depolymerization and crosslinking reactions in coal liquefaction: Final report, 14:46820 (R;US)
Bacterial desulfurization of Turkish lignites, 14:46808 (RA;US)
Coal fragmentation in a fluidized bed combustor, 14:46868 (BA;US)
Comparison of alkali and microbial solubilization of oxidized, low-rank coal, 14:46803 (RA;US)
Correlations for effects of coal type and pressure on tar yields from rapid devolatilization, 14:46853 (BA;US)
Cost-effective sulfur control strategies for the Great Plains gasification project, 14:46825 (BA;US)
Depolymerization of low-rank coals by a unique microbial consortium, 14:46801 (RA;US)
Enzymatic degradation of low-rank coals by a cell-free enzymatic system from coriolus versicolor, 14:46804 (RA;US)
Impacts of cleaning Texas lignite on boiler performance and economics: Final report, 14:46880 (R;US)
Promotion of char oxidation by inorganic constituents, 14:46849 (BA;US)
Quench-induced nucleation of ash constituents during combustion of pulverized coal in a laboratory furnace, 14:46866 (BA;US)
Time-resolved evolution of fly ash during pulverized coal combustion, 14:46865 (BA;US)
LIMESTONE
Dynamic compression and release experiments on Indiana limestone, 14:48164 (R;US)

LINACS
See LINEAR ACCELERATORS
LINEAR ACCELERATORS
Development of ancillary equipment for a linear accelerator, 14:47808 (RA;AT;In German)
Dosimeter readings reproducibility in water phantom measurements at electron accelerators with a beam scanning system, 14:47809 (RA;AT;In German)
Troubles of cardiac pacemakers due to irradiation at a linear accelerator, 14:48125 (RA;AT;In German)
LINEAR COLLIDERS
RF properties of periodic accelerating structures for linear colliders, 14:47815 (R;US)
LINEAR Z PINCH DEVICES
Solid fiber Z-pinches: "Cold-start" computations, 14:48656 (R;US)
LIPIDS
Cadmium sulfide mediated photoelectric effects in bilayer lipid membranes, 14:47540 (J;US)
LIQUEFIED NATURAL GAS
Water-spray barriers for LNG (liquefied natural gas) vapor mitigation. Topical report, September 1987-November 1988, 14:46911 (R;US)
LIQUID CRYSTALS
Chevron layer structures in surface stabilized ferroelectric liquid crystal (SSFLC) cells filled with a material which exhibits the chiral nematic to smetic C* phase transition, 14:47432 (R;US)
LIQUID EFFLUENTS
See LIQUID WASTES
LIQUID FLOW
Non Newtonian gravity creeping flow, 14:48499 (R;XA)
LIQUID FUELS
Behavior of combustible liquid soaked in porous beds during flame spread, 14:46922 (BA;US)
LIQUID METAL COOLANT
See LIQUID METALS
LIQUID METAL TEST FACILITIES
See TEST FACILITIES
LIQUID METAL-WATER REACTIONS
See MOLTEN METAL-WATER REACTIONS
LIQUID METALS
Thermocapillary flow in a pulsed-laser weld pool, 14:47382 (BA;US)
LIQUID WASTES
Field demonstration of in situ vitrification for application to ORNL liquid waste disposal trenches, 14:46952 (RA;US)
Preliminary results of the immobilization of highly-salt-ladened concentrate in cement-based grout: A joint DOE/CEA (Department of Energy/Commissariat a l'Energie Atomique) research effort, 14:47223 (RA;US)
Superfund Record of Decision (EPA Region 5): Republic Steel Quarry Site, Elyria, Ohio (first remedial action), September 1988. Final report, 14:48075 (R;US)
LIQUIDS
Equations of state for hard-sphere fluids, 14:47759 (J;US)
Prediction of shear viscosity and non-Newtonian behavior in the soft-sphere liquid, 14:47526 (J;US)
Selected equation of state in the acentric factor system, 14:47760 (J;US)
LISP
Programming language supporting first-class parallel environments. Technical report, 14:48718 (R;US)
LITHIUM
Ignition and combustion of metals in a carbon dioxide stream, 14:47683 (BA;US)
Production of EMD (electrolytic manganese dioxide) under different gas atmospheres and its application as a cathode material for lithium secondary batteries, 14:47206 (R;JP)
Structural stability calculations for films and crystals, 14:47345 (RA;US)
LITHIUM 7
Value of $B(E2;3/2^- \rightarrow 1/2^-)$ for ^7Li, 14:48439 (R;AU)
LMFBR TYPE REACTORS
A method for suppression of pressure pulses in fluid-filled piping: Theoretical analysis, 14:47099 (R;US)
Evaluation of LMR [liquid metal reactors] core support concepts under seismic events, 14:47131 (R;US)
Investigations of vapour explosions with alumina-droplets in sodium, 14:47145 (R;DE;In German)
Seismic analysis of a large pool-type LMR [liquid metal reactor], 14:47132 (R;US)
LNG
See LIQUEFIED NATURAL GAS
LOCA
See LOSS OF COOLANT
LONG WAVE RADIATION
ELF (extremely low frequency) communications system ecological monitoring program: Summary of 1987 progress. Technical report, 1 January-31 December 1987, 14:48159 (R;US)
LONGITUDINAL PINCH DEVICES (LINEAR)
See LINEAR Z PINCH DEVICES
LONGWALL MINING
Evaluation of air sprays and unique foam application methods for longwall dust control. Research report (Final), 14:46844 (R;US)
LORENTZ INVARIANCE
Lorentz symmetry in the light-cone field theory of open and closed strings, 14:48373 (RA;JP)
LOSS CONE INSTABILITY
Quasilinear relaxation of electron distribution function, 14:48632 (RA;AU)
LOSS OF COOLANT
LOCA [loss-of-coolant accident] analysis of a proposes power increase for MURR [Missouri University Research Reactor] using RELAP5/MOD2, 14:47199 (J;US)
ROSA-IV/LSTF 5% cold leg break LOCA experiment run SB-CL-18 data report, 14:47095 (R;JP)
LOW FREQUENCY RADIATION
See LONG WAVE RADIATION
LOW-LEVEL RADIOACTIVE WASTES
Design features of earth mounded concrete bunkers for LLRW (low-level radioactive waste) disposal, 14:46944 (RA;US)
Design, construction, and operations experience with the SWSA 6 (Solid Waste Storage Area 6) tumulus disposal demonstration, 14:46945 (RA;US)
Drumlins - Potential low-level radioactive waste sites, 14:46949 (RA;US)
Evaluation of commercially available radionuclide assay equipment suitable for solid LLW characterization/certification, 14:46936 (RA;US)
French low-level waste characterization and certification, 14:46935 (RA;US)
INEL studies concerning solidification of low-level waste in cement, 14:46965 (R;US)
Performance assessment for future low-level waste disposal facilities at ORNL, 14:46958 (R;US)
Performance assessment on grouted double-shell tank waste at Hanford, 14:46982 (R;US)
The compatibility of various polymeric liner and pipe materials with simulated double-shell slurry feed at 90°C: Hanford Grout Technology Program, 14:46933 (R;US)
Waste certification at the Y-12 Plant, 14:46938 (RA;US)
[US low-level radioactive waste management facility design, construction, and operation]: Foreign trip report, July 22–30, 1989, 14:46973 (R;US)
LOWER HYBRID HEATING
On lower hybrid wave scatteing by plasma density fluctuation. Nonlinear reflection coefficient of the fast magnetoacoustic wave, 14:48645 (R;CS)
On lower hybrid wave scattering by plasma density fluctuations, 14:48646 (RA;CS)
LOWER HYBRID RESONANCE HEATING
See LOWER HYBRID HEATING
LT-4 TOKAMAK
Tomography of soft X-ray emission on LT-4, 14:48628 (RA;AU)

LUBRICATING OILS
Hot-surface ignition tests of aircraft fluids. Final report, May 1987-May 1988, 14:46901 (R;US)
LUMINOUS FLUX DENSITY
See ILLUMINANCE
LUTETIUM 176
Detailed photonuclear cross-section calculations and astrophysical applications, 14:48484 (R;US)
LYSINE
Examination of the function of active site lysine 329 of ribulose-bisphosphate carboxylase/oxygenase as revealed by the proton exchange reaction, 14:48096 (J;US)

M

M CODES
Causes and control of coal mine bumps, 14:46888 (R;US)
U.S. NRC emergency response dose assessment model, 14:47156 (BA;US)
MA 754
See NICKEL BASE ALLOYS
MA 956
See IRON BASE ALLOYS
MACACA
See MACACUS
MACACUS
Influence of pyridostigmine on the antiemetic effect of domperidone in irradiated macaques, 14:48137 (RA;FR;In French)
Influence of the association pyridostigmine-gamma irradiation (15 Gy) on the physical performances of the macacus cynomolgus, 14:48138 (RA;FR;In French)
MAGMA
Explosive volcanism, shock metamorphism and the K-T boundary, 14:48194 (RA;US)
Noble metals in mid-ocean ridge volcanism: A significant fractionation of gold with respect to platinum group metals, 14:48193 (RA;US)
MAGNESIUM
Differential cross sections and Stokes parameters for electron-magnesium scattering, 14:48257 (R;AU)
Ignition and combustion of metals in a carbon dioxide stream, 14:47683 (BA;US)
Metals in intimate contact, 14:47336 (RA;US)
MAGNET COILS
Study on poloidal field coil optimization and equilibrium control of ITER, 14:48686 (R;JP)
Testing results of the MIT Probe, 14:48694 (R;US)
MAGNETIC BREMSSTRAHLUNG
See SYNCHROTRON RADIATION
MAGNETIC COILS
See MAGNET COILS
MAGNETIC DIPOLES
Non-intrusive verification, 14:47917 (R;US)
MAGNETIC FIELDS
NMR imaging of the high-frequency field, 14:48107 (RA;AT;In German)
MAGNETIC ISLANDS
Effect of symmetry breaking errors on the H-1 plasma configuration, 14:48614 (RA;AU)
MAGNETIC RECONNECTION
Multipoint measurements from substorm onset to recovery: The relation between magnetic pulsations and plasma-sheet thickening, 14:48236 (R;US)
MAGNETIC SPECTROMETERS
Report on design work on the LAMPF QD(-Q) spectrometer: Final report, 14:47845 (R;US)
Specifications for k=600 magnetic spectrometer components, 14:47813 (R;ZA)
MAGNETIC STORMS
Multipoint measurements from substorm onset to recovery: The relation between magnetic pulsations and plasma-sheet thickening, 14:48236 (R;US)
MAGNETIC SURFACES
Electron-beam measurements of the magnetic surfaces in SHEILA, 14:48682 (RA;AU)
MAGNETO-OPTICAL EFFECTS
Two-photon absorption characterization of HgCdTe. Interim report (Annual), August 1987-August 1988, 14:47410 (R;US)
MAGNETOHYDRODYNAMIC CHANNELS
See MHD CHANNELS
MAGNETOHYDRODYNAMIC GENERATORS
See MHD GENERATORS
MAGNETOHYDRODYNAMICS
Equilibrium of solar coronal arcades. Interim report, 14:48175 (R;US)
Resistive magnetohydrodynamic spectra, 14:48631 (RA;AU)
[Pittsburgh Energy Technology Center] quarterly technical progress report for the period ending June 30, 1988, 14:46791 (R;US)
MAGNETOPAUSE
Observations of flux transfer events: Are FTEs flux ropes, islands, or surface waves?, 14:48240 (R;US)
MAGNETOSPHERE
See EARTH MAGNETOSPHERE
MAHOGANY TREES
See TREES
MAIN SEQUENCE STARS
Effects of Cosmions upon the structure and evolution of very low mass stars, 14:48189 (R;US)
Upper main sequence of OB associations. 1: Spectral types and lines of C and N of southern single-lined O stars, 14:48226 (R;CH)
MAINTENANCE
Design of the TFTR [Tokamak Fusion Test Reactor] maintenance manipulator, 14:48703 (J;US)
In-vessel remote maintenance of the Compact Ignition Tokamak, 14:48704 (J;US)
MALIGNANCIES
See NEOPLASMS
MAN
Effect of high radiation doses on human fetuses, 14:48126 (RA;AT;In German)
Long-term investigation of the time dependence of radioactive cesium concentrations in human muscle tissue, 14:48127 (RA;AT;In German)
MANGANESE
Microbial dissolution of toxic metals from coal residues, 14:46839 (RA;US)
MANGANESE OXIDES
Production of EMD (electrolytic manganese dioxide) under different gas atmospheres and its application as a cathode material for lithium secondary batteries, 14:47206 (R;JP)
MANIPULATORS
Design of the TFTR [Tokamak Fusion Test Reactor] maintenance manipulator, 14:48703 (J;US)
Development of an underwater remote manipulator system for use in TMI-2 [Three Mile Island Unit 2] reactor defueling, 14:47192 (J;US)
In-vessel remote maintenance of the Compact Ignition Tokamak, 14:48704 (J;US)
MANITOBA
The development of a hazardous waste management system in Manitoba, 14:47225 (R;CA)
MANOMETERS
See PRESSURE GAGES
MANY-BODY PROBLEM
Present status of the many-body problem, 14:48539 (RA;US)
MARS PLANET
Cratering record in the inner solar system: Implications for earth, 14:48191 (RA;US)
MARYLAND
Bibliography of the Maryland Power Plant and Environmental Review Division, tenth edition, 14:47256 (R;US)
Communicating radon risk effectively: Radon testing in Maryland. Final report, 14:47965 (R;US)

MASERS
High-gain plasma Cerenkov Maser, 14:48665 (J;US)
MASS TRANSFER
A review of GEOTOX for the EPA multi-media assessment project, 14:47986 (R;US)
Calculations of geochemical mass transfer as a function of temperature and time, 14:48167 (RA;US)
Development and application of stable isotope mass transfer reaction path models, 14:47058 (RA;US)
Modeling mass transfer reaction rates: Calcite precipitation and CO_2 outgassing in a Karst steam, 14:47064 (RA;US)
Multiple reaction path model describing mass transfer in geochemical systems, 14:48165 (RA;US)
Numerical studies of identification in nonlinear distributed parameter systems. Final report, 14:48574 (R;US)
MASS TRANSIT SYSTEMS
HRIS (Highway Research Information Service) Abstracts. Volume 21, Number 1 - Spring 1988, 14:47278 (R;US)
MASSACHUSETTS
Massachusetts lake classification program (revised). Final report, 14:48053 (R;US)
MASURIUM
See TECHNETIUM
MATERIALS
Ab initio calculations of materials properties, 14:47335 (RA;US)
Discussion of theoretical techniques in quantum chemistry and solid state physics, 14:47326 (RA;US)
Fracture and flow via nonequilibrium molecular dynamics, 14:48280 (BA;US)
How can materials theory benefit from supercomputers and vice versa?, 14:47324 (RA;US)
Microstructural dynamic study of grain growth, 14:48537 (BA;US)
Multiconfigurational Green's function approaches in quantum chemistry, 14:47416 (RA;US)
Purposes of the assessment, 14:47323 (RA;US)
Relationship between ab initio and semiempirical theories of electronic structure, 14:47325 (RA;US)
The role of trapped interstitials during rapid thermal annealing, 14:47451 (BA;US)
MATERIALS (BIOLOGICAL)
See BIOLOGICAL MATERIALS
MATERIALS (BUILDING)
See BUILDING MATERIALS
MATERIALS (COMPOSITE)
See COMPOSITE MATERIALS
MATERIALS (DOPED)
See DOPED MATERIALS
MATERIALS (FERROMAGNETIC)
See FERROMAGNETIC MATERIALS
MATERIALS (POROUS)
See POROUS MATERIALS
MATERIALS (SEMICONDUCTOR)
See SEMICONDUCTOR MATERIALS
MATERIALS (SHIELDING)
See SHIELDING MATERIALS
MATERIALS TESTING
Materials Aerometric data base for use in developing materials damage functions, 14:47967 (R;US)
MATERIALS TESTING REACTOR JAPAN
See JMTR REACTOR
MATERIALS WORKING
[Current research in advanced materials]: Foreign trip report, May 29–June 3, 1989, 14:47400 (R;US)
MATHEMATICAL MANIFOLDS
Few remarks on anti-invariant quasiumbilical submanifolds, 14:48556 (R;XA)
Survey on conformal flatness and quasiumbilicity of submanifolds, 14:48555 (R;XA)
MATHEMATICAL SPACE
Generalization of the spaces l_p, 14:48545 (R;XA;In French)
MATHEMATICS
Summaries of the FY 1989 Applied Mathematical Sciences Research program, 14:48723 (R;US)
MATRIX MATERIALS
Finite element applications to explore the effects of partial bonding on metal matrix composite properties, 14:47436 (R;US)
Study of the stress wave factor technique for evaluation of composite materials. Final report, 14:47440 (R;US)
Ultrafine microstructure composites prepared by chemical vapor deposition. Annual report, January-December 1988, 14:47408 (R;US)
MATURATION
Kinetics and quantitative analysis of the isomerization and aromatization of fossil steroid hydrocarbons within experiments and in naturally matured sample sequences, 14:46889 (R;DE;In German)
MAXIMUM-LIKELIHOOD FIT
Maximum-likelihood identification of structurally constrained covariances for initial-condition statistics, 14:48538 (R;US)
MAXWELL EQUATIONS
Production of photons in anisotropic spacetimes, 14:48391 (R;XA)
Resistive block methods for electrostatic field solutions with internal elements, 14:48578 (R;US)
MAXWELL-BOLTZMANN EQUATION
See BOLTZMANN EQUATION
MEASURED VALUES
See DATA
MEASURING INSTRUMENTS
A miniature inexpensive oxygen sensing element: Quarterly review, 14:47843 (R;US)
Eoet-Wash constraints on multiple Yukawa interactions and on a coupling to "isospin", 14:48437 (R;US)
High-sensitivity hillside results from the Eoet-Wash experiment, 14:47823 (R;US)
On estimation of uncertainties in analog measurements, 14:47716 (R;US)
Photogrammetric method for determining sink volumes at the Nevada Test Site, 14:47913 (RA;US)
Self-calibrating power angle instrument: Volume 1, A functional overview: Final report, 14:47764 (R;US)
Self-calibrating power angle instrument: Volume 2, Theory, operation, and maintenance: Final report, 14:47765 (R;US)
The effect of degree of aromaticity and alkyl substitution of polyaromatic hydrocarbons on instrumental response factors, 14:46836 (R;US)
MEASURING METHODS
[SCOPE workshop on Landscape boundaries: Consequences for biotic diversity and ecological flows]: Foreign trip report, December 12–15, 1988, 14:47976 (R;US)
MECHANICAL STRUCTURES
Performance of the automated cutting equipment system during the plasma cutting of the TMI-2 [Three Mile Island Unit 2] lower core support assembly, 14:47193 (J;US)
MEETINGS
[Technical Program Committee for the European Nuclear Society/American Nuclear Society meetings]: Foreign trip report, March 26–April 2, 1988, 14:47149 (R;US)
MELANOCYTES
See ANIMAL CELLS
MELTDOWN
The WECHSL-Mod2 code: A computer program for the interaction of a core melt with concrete including the long term behavior. Model description and user's manual, 14:47144 (R;DE)
United States Nuclear Regulatory Commission research program on molten core debris interactions in the reactor cavity, 14:47164 (J;NL)
MEMBRANES
Cadmium sulfide mediated photoelectric effects in bilayer lipid membranes, 14:47540 (J;US)
Cost and performance of membranes for organic control in small systems: Flagler Beach and Punta Gorda, Florida. Final report, 1 June 1986-28 February 1989, 14:48038 (R;US)

MERCURY
Boiling of geothermal waters: precipitation of base and precious metals, speciation of arsenic and antimony, and the role of gas phase metal transport, 14:47060 (RA;US)
Drinking-Water Criteria Document for inorganic mercury (final), July 1988, 14:48066 (R;US)

MERCURY PLANET
Cratering record in the inner solar system: Implications for earth, 14:48191 (RA;US)

MERCURY TELLURIDES
Electron mobility in mercury cadmium telluride, 14:47442 (RA;US)
Two-photon absorption characterization of HgCdTe. Interim report (Annual), August 1987-August 1988, 14:47410 (R;US)
Two-photon absorption characterization. Interim performance report, 28 August-27 November 1988, 14:47409 (R;US)

MESH GENERATION
An algorithm for mesh simplification applied to fracture hydrology, 14:48163 (J;US)
Fission-fusion adaptivity in finite elements for nonlinear dynamics of shells. Annual technical report, 1 October 1987-30 September 1988, 14:48461 (R;US)

MESON RESONANCES
See MESONS

MESON SPECTROSCOPY
Possible evidence for supersymmetry in hadron spectra, 14:48332 (RA;PL)

MESON-DEUTERON INTERACTIONS
See DEUTERIUM TARGET

MESONS
Many-point meson greens functions in the strong-coupling limit of the lattice quantum chromodynamics, 14:48345 (RA;AT;In German)
Polarisation effect of the rho-meson in interactions at 5.7, 12, 22.5 GeV/c, 14:48308 (RA;PL)

METAL INDUSTRY
Fuel cells application in the industrial sector: Task 15, Final report, 14:47284 (R;US)
Superfund Record of Decision (EPA Region 3): Palmerton Zinc Pile, Pennsylvania (second remedial action), September 1988, 14:47970 (R;US)
Superfund Record of Decision (EPA Region 5): Republic Steel Quarry Site, Elyria, Ohio (first remedial action), September 1988. Final report, 14:48075 (R;US)

METAL SPRAYING
See SPRAY COATING

METAL VAPOR LASERS
Solar-powered alkali metal vapor lasers. Final report, 1 August 1986-31 October 1988, 14:47747 (R;US)

METAL-WATER REACTIONS
See MOLTEN METAL-WATER REACTIONS

METALS
Electron-positron annihilation rates in metals, 14:47354 (RA;AT;In German)
Field-assisted bonding of single crystal quartz, 14:47446 (R;US)
Lateral interactions in adsorption: Revelations from phase transitions, 14:47337 (RA;US)
[Program for measurements and models of grain boundary and surface energies of metals and ceramics]: Foreign trip report, March 7–17, 1988, 14:47373 (R;US)
[US-Japan workshop on small specimen test techniques, Tokyo, Japan, and visits to Sapporo, Fukuoka, and Nagoya, Japan, February 17–25, 1988]: Foreign trip report, 14:47372 (R;US)

METEORITES
Asteroid and comet flux in the neighborhood of the earth, 14:48208 (RA;US)
Astrophysical implications of periodicity, 14:48205 (RA;US)
Atmospheric erosion by impacts: An analytic investigation, 14:48211 (RA;US)
Evidence for and implications of an Early Archean terrestrial impact record, 14:48201 (RA;US)
Geological remote sensing signatures of terrestrial impact craters, 14:48197 (RA;US)
Impact, and its implications for geology, 14:48203 (RA;US)
Kara and Ust-Kara impact structures (USSR) and their relevance to the K/T boundary event, 14:48199 (RA;US)
Magnetic reversal spurts: Rain gauges for comet showers, 14:48202 (RA;US)
Non-random cratering flux in recent time, 14:48207 (RA;US)
Provenance of the K/T boundary layers, 14:48198 (RA;US)
Shatter cones: Diagnostic impact signatures, 14:48204 (RA;US)
Tektites: Origin as melts produced by the impact of small projectiles onto dry targets, 14:48212 (RA;US)

METEOROIDS
Isotopic investigations in the area of the Tunguska catastrophe in 1908 year, 14:48200 (RA;US)

METEORS
See METEOROIDS

METER WAVE RADIATION
See RADIOWAVE RADIATION

METHANE
Combustion Kinetics
A computational model of the structure and extinction of strained, opposed flow, premixed methane-air flames, 14:47667 (BA;US)
Basic research on natural gas combustion phenomena. Annual report, September 1987-August 1988, 14:46918 (R;US)
Behavior of methane-oxygen-nitrogen mixtures near flammability limits, 14:47676 (BA;US)
Correlations for smoke points and radiant emission of laminar hydrocarbon diffusion flames, 14:47567 (BA;US)
Discussion of two-photon laser-excited fluorescence as a method for quantitative detection of oxygen atoms in flames, 14:47467 (BA;US)
Experiments on the sooting limits of aerodynamically-strained diffusion flames, 14:47570 (BA;US)
Fractal geometry applications in turbulent combustion data analysis, 14:47585 (BA;US)
Fractal-like character of flamelets in turbulent premixed combustion, 14:47584 (BA;US)
Near-field instantaneous flame and fuel concentration structures, 14:47592 (BA;US)
Pulsed plasma jet igniters: Species measurements in methane combustion, 14:47684 (BA;US)
Structural characteristics of lifted turbulent-jet flames, 14:47614 (BA;US)
The influence of turbulence on the burning velocity of premixed CH_4-H_2 flames with different laminar burning velocities, 14:47604 (BA;US)
The structure an extinction of partially premixed flames burning methane in air, 14:47674 (BA;US)
The structure of turbulent nonpremixed flames, 14:47576 (BA;US)
Time scales of the scalar field in turbulent premixed conical flames, 14:47605 (BA;US)
Transition and stability of turbulent jet diffusion flames, 14:47597 (BA;US)
Velocity and scalar fields of turbulent premixed flames in stagnation flow, 14:47603 (BA;US)

Compression
Raman spectroscopic studies of shock-compressed nitromethane and nitromethane-d_3, 14:47861 (R;US)

Efficiency
Laboratory study of nitrogen miscible displacement of light oil, 14:46892 (R;US)

Ignition
Dynamic effects of autoignition centers for hydrogen and $C_{1,2}$-hydrocarbon fuels, 14:47686 (BA;US)
Energy requirements for spherical ignitions in atmospheric-pressure methane-air mixtures: A computational study, 14:47685 (BA;US)
Promoted high-temperature reactions, 14:47620 (BA;US)
Spark ignition of methane and methanol in ozonized air, 14:46916 (BA;US)

Oxidation
Conversion of methane to liquid hydrocarbons, 14:47019 (R;US)
Partial oxidation reactions of methane and oxygen, 14:47018 (R;US)

Recovery
Three-dimensional hydraulic fracture model development for application to and understanding of coal-bed methane-stimulation treatments. Final report, July 1, 1984-December 16, 1988, 14:46913 (R;US)
Synthesis
Photodynamics of a nickel hydrocorphinoid model of F_{430}, 14:47022 (J;US)

METHANOL
Catalogic hydrogenation of carbon monoxide: Final progress report, September 15, 1988–September 14, 1989, 14:47024 (R;US)
Model Cu/ZnO catalysts for methanol synthesis: The role of surface structure: Progress report, 14:47025 (R;US)
Reactions of hydroxymethyl and hydroxyethyl radicals with molecular and atomic oxygen, 14:47626 (BA;US)
Spark ignition of methane and methanol in ozonized air, 14:46916 (BA;US)
The Department of Energy's Federal Methanol Fleet, 14:47028 (B;US)

METHANOL PLANTS
Economic pre-feasibility study: large-scale methanol fuel production from surplus Canadian forest biomass. Part 1, summary report, 14:47026 (R;CA)

METHOXY RADICALS
Direct measurements of methoxy removal rate constants for collisions with CH_4, Ar, N_2, Xe, and CF_4 in the temperature range 673-973 K, 14:47627 (BA;US)

METHYL ALCOHOL
See METHANOL

METHYL FLUORIDE
Valence electronic structure of CH_3F and CH_3Cl: electron momentum distributions and separation energies, 14:48248 (R;AU)

METHYL RADICALS
Profiles of HCO and CH_3 in CH_4/O_2 and C_2H_4/O_2 flames by resonance ionization, 14:47462 (BA;US)

METHYL-FUEL
See METHANOL

METHYLBENZENE
See TOLUENE

METHYLENE CHLORIDE
Toxicological profile for methylene chloride. Final report, 14:48151 (R;US)

METROPOLITAN AREAS
See URBAN AREAS

MHD CHANNELS
MHD (Magnetohydrodynamics) Integrated Topping Cycle: Sixth quarterly progress report, November 1, 1988–January 31, 1989, 14:47258 (R;US)

MHD EQUILIBRIUM
Equilibrium of solar coronal arcades. Interim report, 14:48175 (R;US)

MHD GENERATOR CDIF
MHD (Magnetohydrodynamics) Integrated Topping Cycle: Sixth quarterly progress report, November 1, 1988–January 31, 1989, 14:47258 (R;US)

MHD GENERATORS
Plasma driven MHD power plant, 14:47259 (RA;AU)

MICROBIAL ENHANCED OIL RECOVERY
See MICROBIAL EOR

MICROBIAL EOR
MEOR [microbial enhanced oil recovery] data base and evaluation of reservoir characteristics for MEOR projects, 14:46891 (R;US)

MICROBIAL FLORA
See MICROORGANISMS

MICROELECTRONIC CIRCUITS
Comparison of superconductive and surface-acoustic-wave signal processing, 14:47763 (R;US)

MICROFLORA
See MICROORGANISMS

MICROORGANISMS
MEOR [microbial enhanced oil recovery] data base and evaluation of reservoir characteristics for MEOR projects, 14:46891 (R;US)
Treatability of hazardous chemicals in soils: Volatile and semivolatile organics, 14:48143 (R;US)

MICROWAVE AMPLIFIERS
High power microwave transmission systems for electron cyclotron resonance plasma heating: Volume IV, Progress report, September 1, 1988–August 31, 1989, 14:48672 (R;US)

MICROWAVE RADIATION
Investigation of radiofrequency/microwave effects upon the central nervous system. Final report, 14:48157 (R;US)
Microwave signal detection using modulation of polymeric optical waveguides: Final report, March–September 1988, 14:47849 (R;US)

MIGRATION (RADIONUCLIDE)
See RADIONUCLIDE MIGRATION

MILITARY EQUIPMENT
Separation of depleted uranium fragments from gun test catchments: Phase 1, Catchment system evaluation and separations methods, 14:46976 (R;US)

MILITARY FACILITIES
Application of minimization techniques to metal preparation and finishing operations in the Air Training Command, 14:47216 (RA;US)
Developing a programmatic approach to investigating and remediating many unrelated comprehensive environmental response, compensation and liability act sites at Kelly Air Force Base, 14:47218 (RA;US)
Draft Environmental Impact Statement. Peacekeeper Rail Garrison Program. Executive summary, 14:48081 (R;US)
Energy forecasting and analysis system for the US Army Materiel Command. Final report, 14:47248 (R;US)
Life cycle cost analyses of US Air Force heating plants, 14:47208 (R;US)
Preliminary assessment/site investigation: Tooele Army Depot, Utah. Volume 2. South Area. Final report, 14:48017 (R;US)
Waste minimization at Vandenberg Air Force Base - cast studies, 14:47215 (RA;US)

MILITARY PERSONNEL
Epidemiologic investigation of health effects in Air Force personnel following exposure to herbicides. Summary mortality update, 1989. Interim report 1979-1987, 14:48113 (R;US)

MILK
[Workshop on the Biospheric Model Validation Study (BIOMOVS)]: Foreign trip report, November 7–11, 1988, 14:47929 (R;US)

MILL TAILINGS
Design of a disposal cell for uranium mill tailings at Collin's Ranch, Oregon: A case study in informal dynamic optimization, 14:46947 (RA;US)
Eenie, meenie, minie, moe, where do Monument Valley tailings go?, 14:46948 (RA;US)
Radium and heavy metal transport beneath an abandoned uranium tailings dam, 14:46984 (R;AU)

MINE-MOUTH GENERATING PLANTS
See FOSSIL-FUEL POWER PLANTS

MINERALOGY
Mineralogy-petrology studies and natural barriers at Yucca Mountain, Nevada, 14:46970 (R;US)

MINERALS
Software for the computation and graphical display of intensive variable phase diagrams, 14:48170 (RA;US)

MINES
Characterization of surface properties affecting the activity of the 'free silica' fraction of respirable dusts. Final report, 14:47943 (R;US)

MISGURNUS
See FISHES

MISSILES
A model to calculate effectiveness of a submarine-launched nuclear ASW weapon, 14:48708 (R;US)

Draft Environmental Impact Statement. Peacekeeper Rail Garrison Program. Executive summary, 14:48081 (R;US)

MISSISSIPPI
Biomass energy for Mississippi, 14:47030 (R;US)

MISSOURI UNIVERSITY/COLUMBIA RESEARCH REACTOR
See MURR REACTOR

MIXED OXIDE FUELS
Actual experience in burnup determination of mixed oxide fuel, 14:47477 (RA;XA)

MM-0011
See NICKEL BASE ALLOYS

MODELS (CRYSTAL)
See CRYSTAL MODELS

MODELS (FLOW)
See FLOW MODELS

MODELS (PLASMA)
See PLASMA SIMULATION

MODELS (SCALE)
See SCALE MODELS

MODELS (STAR)
See STAR MODELS

MOLDAVITES
See TEKTITES

MOLDS
See FUNGI

MOLECULAR FLUORESCENCE SPECTROSCOPY
See FLUORESCENCE SPECTROSCOPY

MOLECULAR IONS
Intermediate-velocity molecular and atomic ions in solids, 14:48528 (J;NL)

MOLECULAR ORBITAL MODEL
See MOLECULES

MOLECULES
Electronic properties of liquid silicon, 14:47452 (BA;US)

MOLTEN CARBONATE FUEL CELLS
Market assessment for hydrogen from the catalyzed gasification of low-rank coals, 14:47076 (BA;US)

MOLTEN METAL-WATER REACTIONS
United States Nuclear Regulatory Commission research program on molten core debris interactions in the reactor cavity, 14:47164 (J;NL)

MOLYBDATES
Studies of supported hydrodesulfurization catalysts: Progress report for period January 1, 1989–December 31, 1989, 14:47484 (R;US)

MOLYBDENUM
Calculations of resistivity and superconducting T_c in transition metals, 14:48536 (BA;US)
Combined implantation of carbon and nitrogen ions in molybdenum, 14:47362 (RA;SU;In Russian)
Effect of implantation on microhardness of niobium and molybdenum, 14:47367 (RA;SU;In Russian)
Interactive chemistry of coal-petroleum processing: Quarterly report, March 16, 1989–June 15, 1989, 14:46898 (R;US)
Studies of supported hydrodesulfurization catalysts: Progress report for period January 1, 1989–December 31, 1989, 14:47484 (R;US)

MOLYBDENUM COMPLEXES
ESR study of Mo(5) complexes with phosphorus- and arsenic-containing ligands, 14:47493 (RA;SU;In Russian)
Molybdenum (5) different-ligand complexes with 1,1,'- and 1,2-dithiols, 14:47519 (RA;SU;In Russian)
Spectroscopic study of hydrophobic interactions in coordination compounds with ligands modified by surfactants, 14:47506 (RA;SU;In Russian)

MOLYBDENUM COMPOUNDS
$MoOCl_3$ interaction with amines in the presence of dithioligands, 14:47490 (RA;SU;In Russian)

MOLYBDENUM OXIDES
Absorption jump mechanism of EPR in WO_3, MoO_3 compounds of heteropolyanion type, 14:48508 (RA;SU;In Russian)

MOLYBDENUM SULFIDES
Chemical effects of Ne(+) bombardment on the $MoS_2(0001)$ surface studied by high-resolution photoelectron spectroscopy. Technical report, 14:48495 (R;US)
Low severity coal conversion by ionic hydrogenation: Progress report, May–July 1989, 14:46819 (R;US)

MOLYBDOPHOSPHATES
Different-ligand complexes of some d-metals with monovacant heteropolyanions, 14:47523 (RA;SU;In Russian)

MONGRELS
See DOGS

MONILIA
See CANDIDA

MONITORS (BEAM)
See BEAM MONITORS

MONITORS (RADIATION)
See RADIATION MONITORS

MONOCHLOROETHYLENE
See VINYL CHLORIDE

MONOCHROMATORS
Workshop on cooling of x-ray monochromators on high power beamlines, 14:47812 (R;JP)

MONOCLONAL ANTIBODIES
Target-specific binding of immunoliposomes in vivo, 14:48101 (R;US)

MONOCRYSTALS
High-temperature superconductors: physical properties of single crystalline- and polycrystalline samples, and of thin films, 14:47423 (RA;AT;In German)
Mass-spectrometric depth profile analysis of $YBa_2Cu_3O_x$ single crystals, 14:47422 (RA;AT;In German)

MONTE CARLO METHOD
Microcanonical Monte Carlo, 14:48579 (BA;US)

MOON
Cratering record in the inner solar system: Implications for earth, 14:48191 (RA;US)
Non-random cratering flux in recent time, 14:48207 (RA;US)

MOTORS
Transient phenomena in asynchronous motor drive, 14:47082 (R;FI;In Finnish)

MOUND LABORATORY
Operating experience with the hydrogen isotope separation system at MOUND, 14:48701 (J;US)

MULTI-PHOTON PROCESSES
Two-photon absorption characterization. Interim performance report, 28 August-27 November 1988, 14:47409 (R;US)

MULTICHARGED IONS
Synchrotron-radiation experiments with recoil ions, 14:48244 (R;US)

MULTIPLE PRODUCTION
Leading particle effect at higher energies, 14:48336 (RA;PL)
Novel approach to scaling in multiplicity, 14:48338 (RA;PL)

MULTIPLICITY
Q^2 and W dependence of multiplicities in μ^+p scattering at 280 GeV, 14:48312 (RA;PL)

MULTIPROCESSING
See PARALLEL PROCESSING

MULTIPROCESSORS
See ARRAY PROCESSORS

MULTIWIRE DRIFT CHAMBERS
See DRIFT CHAMBERS

MUNICIPAL WASTES
Anaerobic digestion: Annual report, FY 1988, 14:47027 (R;US)
Locating and estimating air-toxics emissions from municipal-waste combustors. Final report, August 1988-March 1989, 14:47955 (R;US)
Pilot-scale HCl control by dry alkaline injection for emissions from refuse incinerators. Technical report, 14:47946 (R;US)
Study and assessment of eight yard waste-composting programs across the United States. Technical report, 14:47299 (R;US)
Superfund Record of Decision (EPA Region 3): Dorney Road Landfill Superfund Site, Lehigh County, Pennsylvania (first remedial action), September 1988, 14:48002 (R;US)

Superfund Record of Decision (EPA Region 3): Wildcat Landfill, Kent County, Delaware (first remedial action), June 1988, 14:48003 (R;US)
Superfund Record of Decision (EPA Region 5): Kummer Sanitary Landfill, Beltrami County, Minnesota (second remedial action) September 1988, 14:48006 (R;US)
Toxicity Reduction Evaluation protocol for municipal wastewater treatment plants. Report for 1 February-30 September 1988, 14:48045 (R;US)
Wetlands and waste-water management: Questions, answers, advice, and guidance. Technical report, 14:48063 (R;US)

MUON-CATALYZED FUSION
Experimental investigations on muon-catalyzed nuclear fusion, 14:48673 (RA;AT;In German)
Measurement of sticking probability in muon-catalysed fusion, 14:48678 (RA;AT;In German)
Muon catalyzed fusion in plasma state and high intensity DT fusion neutron source, 14:48667 (R;US)
Muon catalyzed fusion: effect of an electric field, 14:48266 (RA;AU)

MUON-PROTON INTERACTIONS
Q^2 and W dependence of multiplicities in μ^+p scattering at 280 GeV, 14:48312 (RA;PL)
Search for higher twist effects in hadronic distributions from μp interactions, 14:48313 (RA;PL)

MUONS
Study of muons associated with jets in proton-antiproton collisions at $\sqrt{s}$ = 1.8 TeV, 14:48297 (R;US)

MURR REACTOR
LOCA [loss-of-coolant accident] analysis of a proposes power increase for MURR [Missouri University Research Reactor] using RELAP5/MOD2, 14:47199 (J;US)

MUSCLES
Long-term investigation of the time dependence of radioactive cesium concentrations in human muscle tissue, 14:48127 (RA;AT;In German)

MUSCULAR TISSUE
See MUSCLES

MUSEUMS
See EDUCATIONAL FACILITIES

MUSSELS
Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (North and Mid-Atlantic): Blue mussel, 14:48015 (R;US)

MUTAGENS
[Short-term assays for detecting environmental mutagens, carcinogens, and teratogens]: Foreign trip report, February 4–28, 1989, 14:48145 (R;US)

MUTATIONS
Spontaneous genomic instability in humans: Final report, 14:48086 (R;US)

N

N-REACTOR
Physics support analyses for full central-zone flux flattening for full-power (3000- to 4000-MW) operation, 14:47113 (R;US)
RELAP5/MOD2.5 thermal hydraulic analysis for an alternate fuel desig in the N Reactor, 14:47135 (R;US)
Xenon transient simulation for N Reactor, 14:47124 (R;US)

NAI DETECTORS
Detector system for gamma-ray production cross section measurements and data analysis, 14:47829 (R;JP;In Japanese)

NAPAP
Flexible Regional Emissions Data System (FREDS) documentation for the 1985 NAPAP (National Acid Precipitation Assessment Program) emissions inventory. Final report, 14:47969 (R;US)

NAPHTHENES
See CYCLOALKANES

NATIONAL ACID PRECIPITATION ASSESSMENT PROGRAM
See NAPAP

NATIONAL INSTITUTE FOR PETROLEUM AND ENERGY RESEARCH
See NIPER

NATIONAL REACTOR TESTING STATION
See IDAHO NATIONAL ENGINEERING LABORATORY

NATIONAL SECURITY
Statement on superconductivity, 14:47714 (R;US)
Strategic Defense Initiative, 1989. Report to the Congress, 14:48753 (R;US)

NATIONAL SYNCHROTRON LIGHT SOURCE
See NSLS

NATURAL ACTIVITY
See NATURAL RADIOACTIVITY

NATURAL GAS
Dedicated low-pressure natural gas-fueled vehicle baseline assessment. Task 3 topical report on light-duty vehicles. Topical report, January 1987-January 1989, 14:47318 (R;US)
Lift-off heights in underexpanded natural gas jet flames, 14:47613 (BA;US)
Reduction of NO_x emission in turbulent combustion by fuel-staging/effects of mixing and stoichiometry in the reduction zone, 14:46915 (BA;US)
The influence of the pricing of networked energy carriers on the efficient use of energy in Hesse. Final report, 14:47255 (R;DE;In German)

NATURAL GAS APPLIANCES
See GAS APPLIANCES

NATURAL GAS DEPOSITS
5-year outer continental shelf oil and gas leasing program, Mid-1987 to Mid-1992: Supplemental environmental impact statement: Draft, 14:48083 (R;US)
Gulf of Mexico Sales 123 and 125: Central and Western Planning Areas: Final Environmental Impact Statement, 14:48082 (R;US)

NATURAL GAS INDUSTRY
Assessment of the effect on the gas industry of the National Appliance Energy Conservation Act of 1987. Topical report, November 1988, 14:46908 (R;US)
Gas Research Institute 1988 annual report. Benefits, balance, broad industry cooperation, 14:46904 (R;US)
Gas Research Institute: an update, January 1989, 14:46909 (R;US)
Gas Research Institute: overview, January 1989, 14:46910 (R;US)

NATURAL GAS WELLS
A laboratory investigation of foam flow in sandstone at elevated pressure, 14:46894 (BA;US)

NATURAL RADIOACTIVITY
Central radon data base and digitized bedrock map of US EPA (Environmental Protection Agency) Region 1. Technical report, 14:47964 (R;US)

NAVAL REACTORS
See SHIP PROPULSION REACTORS

NAVIER-STOKES EQUATION
See NAVIER-STOKES EQUATIONS

NAVIER-STOKES EQUATIONS
3D (three-dimensional) Navier-Stokes flow analysis for a large-array multiprocessor. Final technical report, 14 September 1988-29 February 1989, 14:48283 (R;US)

NEGATONS
See ELECTRONS

NEGATRONS
See ELECTRONS

NEODYMIUM 146
Actual experience in burnup determination of mixed oxide fuel, 14:47477 (RA;XA)

NEODYMIUM 147
Actual experience in burnup determination of mixed oxide fuel, 14:47477 (RA;XA)

NEODYMIUM ALLOYS
Liquid Dynamic Campaction of Fe-Nd-B permanent magnets. Final report, 1 September 1984-31 December 1988, 14:47327 (R;US)

NEODYMIUM COMPOUNDS
Superconductivity and magnetic scattering in the $Nd_{2-x}Ce_xCuO_{4-\delta}$, 14:48535 (R;US)
NEON
Spatial non-uniformity in discharges in low pressure helium and neon, 14:48246 (R;AU)
Structural stability calculations for films and crystals, 14:47345 (RA;US)
NEOPLASMS
Brachytherapy with I-125: a novel implantation system, 14:48109 (RA;AT;In German)
Multiple endpoints for somatic mutations in humans provide complementary views for biodosimetry, genotoxicity, and health risks, 14:48094 (R;US)
Simultaneous application of irradiation and hyperthermia for tumor therapy, 14:48108 (RA;AT;In German)
[Collaborative research on the tumor antigen TSP-180]: Foreign trip report, July 1–17, 1988, 14:48088 (R;US)
NEPTUNIUM COMPOUNDS
Oxygen-17 NMR of seven-valent neptunium in aqueous solution, 14:47556 (J;US)
NETWORKS (COMPUTER)
See COMPUTER NETWORKS
NEUTRAL PARTICLES
Positron line radiation from halo WIMP annihilations as a dark matter signature, 14:48216 (R;US)
Studies on ions and neutrals desorbed from solid surfaces by ion and electron bombardment. Final report, 1 November 1984-31 October 1988, 14:48494 (R;US)
NEUTRALIZATION (CHEMICAL)
See PH VALUE
NEUTRINO OSCILLATION
UCI mobile neutrino experiment, 14:48304 (RA;PL)
NEUTRINO REACTIONS
Recent results on coherent and incoherent particle production in ν-nucleus interactions below 30 GeV, 14:48306 (RA;PL)
NEUTRINO-NUCLEON INTERACTIONS
Overview of νN and ν-barN interactions, 14:48310 (RA;PL)
NEUTRINOS
Neutrinos beyond the Standard Model, 14:48357 (R;US)
NEUTRON CAPTURE
See NEUTRON REACTIONS
NEUTRON DIFFRACTION
Neutron phase shift near a dynamic Bragg reflection, 14:48567 (RA;AT;In German)
Resonance effects in neutron scattering lengths, 14:48487 (R;US)
NEUTRON DIFFUSION EQUATION
Domain decomposition method for solving the neutron diffusion equation, 14:48488 (R;FR;In French)
NEUTRON MATTER
See NUCLEAR MATTER
NEUTRON RADIOGRAPHY
SNRS [stationary neutron radiography system] component positioning systems, 14:47730 (J;US)
NEUTRON REACTIONS
Measurement of activation cross sections, 14:48433 (R;JP;In Japanese)
NEUTRON SOURCES
Easy method of a neutron skyshine calculation and its application to the Japanese Hadron Project, 14:48490 (R;JP;In Japanese)
NEUTRONS
Measurement of Berry's topological phase for non-cyclic evolution, 14:48566 (RA;AT;In German)
Measurement of total neutron cross-sections for determination of the electric polarizability of the neutron, 14:48315 (RA;AT;In German)
NEVADA TEST SITE
Applications of vertical seismic profiling at NTS, 14:47894 (RA;US)
Borehole inspection system for large diameter holes, 14:47891 (RA;US)
Breathing on the Mesa, 14:47903 (RA;US)
Definition of stratigraphic units between the Grouse Canyon and Rainier Mesa tuffs in Los Alamos-use areas of Yucca Flat, Nevada Test Site, 14:47892 (RA;US)
Geologic and hydrologic investigations at the ALEMAN (U3KZ) site, and other sites in Yucca Flat, the Nevada Test Site, 14:47909 (RA;US)
Geologic and material property combinations that adversely influence residual stress in 2-D dynamic containment calculations, 14:47878 (RA;US)
High fluid levels in drill holes, Yucca Flat, Nevada Test Site, 14:47907 (RA;US)
Measurement of in situ strength using projectile penetration: Tests of a new launching system, 14:47897 (RA;US)
Mixed waste characterization and certification at the Nevada Test Site, 14:46939 (RA;US)
Possible relation between sonic velocity measured at the edge of a large borehole and shear failure, 14:47895 (RA;US)
Pre- and post-event elevation and horizontal surveys across the Yucca and Topgallant faults, Nevada Test Site, 14:47893 (RA;US)
Relationship between large-hole drilling rates and compressive strength of NTS rock types, 14:47896 (RA;US)
Spectral reflectance characteristics of clay-bearing soils: Applications to downhole environments, 14:47898 (RA;US)
Temperature logging as an aid to understanding groundwater flow in NTS boreholes, 14:47908 (RA;US)
NEW MEXICO
Application of EQ3/6 to modeling the chemical evolution in hydrothermal systems: An example at the Valles Caldera, N.M., 14:47062 (RA;US)
NEWTON MECHANICS
See CLASSICAL MECHANICS
NICKEL
Annealing of radiation defects in region of 3 stage in nickel and in nickel-titanium alloy, 14:47361 (RA;SU;In Russian)
Electronic structure calculations for low coverage adlayers, 14:46794 (RA;US)
Estimation of drift intensities of point defects based on recombination process, 14:47360 (RA;SU;In Russian)
Microbial dissolution of toxic metals from coal residues, 14:46839 (RA;US)
Semiempirical molecular orbital modeling of catalytic reactions including promoter effects, 14:47346 (RA;US)
Study of radiation damages of Ni monocrystals implanted with Xe^+ ions, 14:47369 (RA;SU;In Russian)
Theoretical considerations regarding impurities in silicon and the chemisorption of simple molecules on nickel, 14:47343 (RA;US)
NICKEL ALLOYS
Annealing of radiation defects in region of 3 stage in nickel and in nickel-titanium alloy, 14:47361 (RA;SU;In Russian)
Simulation of equilibrium segregation in alloys using the Embedded Atom method, 14:47379 (BA;US)
Weldability of ductile nickel aluminides, 14:47374 (R;US)
NICKEL BASE ALLOYS
New interpretation of rupture strength using the potential drop technique, 14:47383 (BA;US)
Polishing methods for metallic and ceramic transmission electron microscopy specimens: Revision 1, 14:47329 (R;US)
The effect of hydrogen on the deformation and fracture of PWA 1480, 14:47381 (BA;US)
NICKEL COMPLEXES
Cyclopentane formation in the reduction of 1,5-dihaloalkanes with a nickel(I) macrocycle, 14:47023 (J;US)
Photodynamics of a nickel hydrocorphinoid model of F_{430}, 14:47022 (J;US)
NIOBIUM
Breakdown of chromium oxide scales in sulfur-containing environments at elevated temperatures, 14:47385 (J;US)
Calculations of resistivity and superconducting T_c in transition metals, 14:48536 (BA;US)
Effect of implantation on microhardness of niobium and molybdenum, 14:47367 (RA;SU;In Russian)

Partial oxidation reactions of methane and oxygen, 14:47018 (R;US)

NIOBIUM ALLOYS
Materials by design, 14:47380 (BA;US)
Thermal conduction of SSC [Superconducting Super Collider] wire, 14:47352 (R;US)

NIOBIUM BASE ALLOYS
Creep behavior of tungsten fiber reinforced niobium metal matrix composites, 14:47351 (R;US)
Temperature and amplitude dependence of internal friction in tantalum, niobium, dysprosium irradiated with electrons, 14:47366 (RA;SU;In Russian)
The interface in tungsten fiber reinforced niobium metal-matrix composites, 14:47421 (R;US)

NIOBIUM COMPLEXES
Investigation of processes of $NbCl_5$ complexing with β-diketones, 14:47498 (RA;SU;In Russian)
NMR study of addition products of metal alkoxides with low-coordinated phosphorus compounds, 14:47496 (RA;SU;In Russian)

NIPER
[National Institute for Petroleum and Energy Research] 1988 annual report, 14:46893 (R;US)

NITRATES
Extent and trend of nitrate contamination in Region III: The Coastal Plain and Piedmont Province. Technical report, 14:48034 (R;US)

NITRIC ACID
Nitric acid shootout: field comparison of measurement methods (journal version), 14:47937 (R;US)

NITRIC OXIDE
Laser-fluorescence measurements of nitric oxide in low-pressure H_2/O_2/NO flames, 14:47640 (BA;US)

NITRO COMPOUNDS
Model calculations and experimental measurements of the response of HMX porous beds to deflagration and shock, 14:47865 (R;US)
Raman spectroscopic studies of shock-compressed nitromethane and nitromethane-d_3, 14:47861 (R;US)
Sensitivity relationships in energetic materials, 14:47859 (R;US)

NITROGEN
Laboratory study of nitrogen miscible displacement of light oil, 14:46892 (R;US)
Measurements of nitrogen Q-branch foreign gas-broadening coefficients relevant to flames, 14:47464 (BA;US)
Theoretical considerations regarding impurities in silicon and the chemisorption of simple molecules on nickel, 14:47343 (RA;US)

NITROGEN 20
Observations of ^{20}N via the heavy-ion transfer reaction $^{48}Ca(^{18}O,^{20}N)^{46}Sc$, 14:48441 (R;AU)

NITROGEN COMPOUNDS
Pulverized coal combustion: Fuel nitrogen mechanisms in the rich post-flame, 14:46873 (BA;US)

NITROGEN DIOXIDE
Nitrogen dioxide formation by the mixing of hot combustion gas with cold air, 14:47641 (BA;US)
Numerical simulation study of a hydrazine/nitrogen dioxide diffusion flame in a Burke-Schumann burner, 14:47696 (BA;US)

NITROGEN HYDRIDES
Detailed kinetic studies on elementary NH_2-reactions, 14:47639 (BA;US)

NITROGEN IONS
Ionisation processes in low pressure N_2 plasmas, 14:48610 (RA;AU)

NITROGEN NITRIDES
See NITROGEN

NITROGEN OXIDES
1988 annual report of the Integrated Forest Study, 14:47933 (R;US)
Advanced NO_x reduction processes using -NH and -CN compounds in conjunction with staged air addition, 14:46874 (BA;US)
Formation of NO_x and burnoff of CO during thermal quenching of the products from combustion in a thermally stabilized burner, 14:47642 (BA;US)
Reduction of NO_x emission in turbulent combustion by fuel-staging/effects of mixing and stoichiometry in the reduction zone, 14:46915 (BA;US)
Reduction of NO_x emissions in a swirled coal flame by particle injection into the internal recirculation zone, 14:46872 (BA;US)
Stationary combustion: The environmental leitmotiv, 14:46846 (BA;US)
The reduction of NO_x emissions from a fluidized bed combustor by staged combustion combined with ammonia addition, 14:46875 (BA;US)

NMR
See NUCLEAR MAGNETIC RESONANCE

NOBLE GASES
See RARE GASES

NON-DISPERSIVE ION WAVES
See ION ACOUSTIC WAVES

NON-INDUCTIVE CURRENT DRIVE
RMF current drive in cylindrical plasmas - the saga continues, 14:48596 (RA;AU)
Review of RF current drive, 14:48602 (RA;AU)
Theoretical study of RF current drive in the rotamak, 14:48597 (RA;AU)

NON-PROLIFERATION TREATY
Intermediate-range nuclear forces (INF) treaty: History of an illusion, 14:47320 (R;US)

NONLINEAR PROBLEMS
Fission-fusion adaptivity in finite elements for nonlinear dynamics of shells. Annual technical report, 1 October 1987-30 September 1988, 14:48461 (R;US)
Nonlinear reflection coefficient of the fast magnetoacoustic wave, 14:48647 (RA;CS)
Numerical studies of identification in nonlinear distributed parameter systems. Final report, 14:48574 (R;US)

NONLINEAR SYSTEMS
See NONLINEAR PROBLEMS

NONLUMINOUS MATTER
Positron line radiation from halo WIMP annihilations as a dark matter signature, 14:48216 (R;US)

NONRADIOACTIVE WASTE DISPOSAL
See WASTE DISPOSAL

NORTHERN IRELAND
See UNITED KINGDOM

NOVAE
High-speed optical photometry of the DQ Herculis object H2215-086, 14:48231 (J;US)

NOZZLES
Three dimensional thermal analysis of rocket thrust chambers, 14:47754 (R;US)

NPR REACTOR
See N-REACTOR

NRTS
See IDAHO NATIONAL ENGINEERING LABORATORY

NSLS
The national synchrotron light source and its applications, 14:47781 (R;US)

NUCLEAR ATTACKS
See NUCLEAR WEAPONS

NUCLEAR CASCADES
Development of electron-photon cascades in lead and layers of lead-scintillator, 14:48489 (RA;PL)

NUCLEAR CONTROVERSY
See HUMAN POPULATIONS

NUCLEAR DATA COLLECTIONS
Assessment of the current status of basic nuclear data compilations, 14:48429 (R;US)

NUCLEAR EMULSIONS
Fluctuation analysis of relativistic nucleus-nucleus collisions in emulsion chambers, 14:47831 (RA;US)

NUCLEAR ENERGY
Conversion of NE [nuclear energy] standards to national consensus standards, 14:47246 (R;US)

NUCLEAR EXPLOSIONS
Communication facility EMP (electromagnetic pulse) assessment. Topical report, 1 September 1975-30 March 1979, 14:47866 (R;US)
Comparison of hot particles in the Chernobyl fallout and in the nuclear weapons tests fallout, 14:47960 (RA;AT;In German)
Fission-product-decay characteristics. Master's thesis, 14:48463 (R;US)
Non-intrusive verification, 14:47917 (R;US)
Recent developments in hydrofracture calculations related to containment, 14:47874 (RA;US)
Seismic verification studies at Sandia, 14:47916 (R;US)
Updating nuclear effects in theater models. Final report, 14:47869 (R;US)
Visibility in an atmospheric nuclear dust cloud. Master's thesis, 14:47867 (R;US)
[Dose and dose-rate effects on radiation response]: Foreign trip report, May 5–13, 1989, 14:48135 (R;US)

NUCLEAR EXPLOSIVES
Energy in physics, war and peace, 14:47016 (B;US)

NUCLEAR FACILITIES
ANSTO resources, 14:48710 (R;AU)
Nuclear fission and nuclear safeguards: Common technologies and challenges, 14:47008 (R;US)
Results of the radiological survey at 142 West Central Avenue, Maywood, New Jersey (MJ041), 14:47998 (R;US)
Results of the radiological survey at 205 Main Street, Lodi, New Jersey (LJ075), 14:47996 (R;US)
Results of the radiological survey at 88 East Central Avenue, Maywood, New Jersey (MJ037), 14:47997 (R;US)
Results of the radiological survey at 9 Redstone Lane, Lodi, New Jersey (LJ069), 14:47995 (R;US)
Supplemental information for a notice of construction for the Fueled Clad Fabrication System, the Radioisotope Power Systems Facility, and the Fuel Assembly Area, 14:46985 (R;US)

NUCLEAR FUEL ELEMENTS
See FUEL ELEMENTS

NUCLEAR INDUSTRY
Financial impact of implementing draft ANSI Standard N13.30, performance criteria for radiobioassay, 14:47148 (R;US)

NUCLEAR MAGNETIC RESONANCE
NMR imaging of the high-frequency field, 14:48107 (RA;AT;In German)

NUCLEAR MATERIALS MANAGEMENT
Automated data collection (ADC) extension of a generic computerized nuclear material accountability system, 14:47006 (R;US)

NUCLEAR MATTER
[Cluster structure in nuclear and subnuclear matter, Kyoto, Japan, July 25–29, 1988]: Foreign trip report, 14:48479 (R;US)

NUCLEAR PHYSICS
GSI scientific report 1988, 14:48431 (R;DE)
HMI Section of Nuclear and Radiation Physics - annual report 1988, 14:48432 (R;DE;In German)
Nuclear Physics Laboratory, University of Washington annual report, 1989, 14:48430 (R;US)
Physics Division annual review, April 1, 1988–March 31, 1989, 14:48426 (R;US)
[International conference on applications of nuclear techniques, Crete, Greece, and visit to Utrecht, Netherlands, June 27–July 8, 1988]: Foreign trip report, 14:47835 (R;US)
[Workshop on gross properties of nuclei and nuclear excitations]: Foreign trip report, January 12–February 4, 1989, 14:48483 (R;US)

NUCLEAR POWER
Role of IAEA [International Atomic Energy Agency] safeguards in confidence building, 14:47247 (R;US)

NUCLEAR POWER PLANTS
Aging and service wear of electric motor-operated valves used in engineered safety-feature systems of nuclear power plants: Aging assessments and monitoring method evaluations, 14:47147 (R;US)
Analysis and management of risks from the nuclear fuel cycle. Final report of the co-ordinated research programme on development of risk criteria for the nuclear fuel cycle, 14:47083 (R;XA)
Analysis of the role of regulation in the escalation of capital additions costs for nuclear power plants, 14:47103 (R;US)
Data book of the component failure rate stored in the RECORD, 14:47106 (R;JP;In Japanese)
Design and fabrication Code Case acceptability, ASME Section 3, Division 1, 14:47108 (R;US)
EPRI workshop on fire protection in nuclear power plants: Final report, 14:47138 (R;US)
Financial impact of implementing draft ANSI Standard N13.30, performance criteria for radiobioassay, 14:47148 (R;US)
Managing the effects of aging and reliability improvement, 14:47163 (J;NL)
Nuclear power plants: Using PSA to enhance operational safety, 14:47161 (J;XA)
Operational data collection and analysis for nuclear plant life extension, 14:47088 (R;US)
Survey of incidents in West German nuclear power plants in the first quarter of the year 1989, 14:47142 (R;DE;In German)

NUCLEAR POWER STATIONS
See NUCLEAR POWER PLANTS

NUCLEAR PUMPING
Proof of the feasibility of coherent and incoherent schemes for pumping a gamma-ray laser. Quarterly technical progress report, 1 October-31 December 1988, 14:48462 (R;US)

NUCLEAR REACTIONS
Fluctuation analysis of relativistic nucleus-nucleus collisions in emulsion chambers, 14:47831 (RA;US)
Half-shell scattering on Coulomb-distorted Graz potentials, 14:48469 (R;XA)
Size of the particle emission region in relativistic nuclear collisions from two-particle interferometry, 14:48472 (RA;PL)

NUCLEAR SAFETY
See RADIATION PROTECTION

NUCLEAR SPIN RESONANCE
See NUCLEAR MAGNETIC RESONANCE

NUCLEAR STRUCTURE
[Mass-chain nuclear structure and nuclear decay, Ghent, Belgium, May 16–20, 1988]: Foreign trip report, 14:48435 (R;US)
[Nuclear structure physics]: Foreign trip report, May 9–June 14, 1988, 14:48478 (R;US)

NUCLEAR THEORY
Theoretical studies in nuclear reactions and nuclear structure: Progress report, 14:48466 (R;US)
[International conference on nuclear physics]: Foreign trip report, May 20, 1988–August 31, 1988, 14:48482 (R;US)

NUCLEAR WASTES
See RADIOACTIVE WASTES

NUCLEAR WEAPON TESTS
See NUCLEAR EXPLOSIONS

NUCLEAR WEAPONS
Energy in physics, war and peace, 14:47016 (B;US)
Instructions for using SOW Pk program, 14:48754 (R;US)
Intermediate-range nuclear forces (INF) treaty: History of an illusion, 14:47320 (R;US)
Target acquisition methodology enhancement (TAME). Final report, March 1988-March 1989, 14:47868 (R;US)
Updating nuclear effects in theater models. Final report, 14:47869 (R;US)
[Participation in the Genetic Sub-subgroup at the United Nations Scientific Committee on the Effects of Atomic Radiation]: Foreign trip report, June 13–17, 1988, 14:48131 (R;US)

NUCLEI
Factors in EMC effect, 14:48471 (RA;PL)
Giant nuclear resonances, 14:48465 (R;US)
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NUCLEON-ANTINUCLEON INTERACTIONS
A consistent meson-theoretical model of the nucleon-antinucleon interaction, 14:48356 (R;DE;In German)

NUCLEON-NUCLEON INTERACTIONS
Quark-gluon plasma, 14:48343 (RA;AT;In German)
NUCLEONS
Experimental limits on the nucleon lifetime from the Irvine - Michigan - Brookhaven (IMB) detector, 14:48307 (RA;PL)
[Nucleus-Nucleus Collisions]: Foreign trip report, June 6, 1988–June 21, 1988, 14:48477 (R;US)
[Nucleus-nucleus collisions]: Foreign trip report, June 5–11, 1988, 14:48476 (R;US)
NUCLEOTIDYLTRANSFERASES
Radioactive-electrophoretic assay of adenosine 5'-triphosphate sulfurylase activity in crude extracts with sulfate or selenate as a substrate, 14:48095 (J;US)
NUCLIDES
See ISOTOPES
9J-SYMBOLS
See WIGNER COEFFICIENTS

O

O CODES
Parallel implementation of OPS5 on the Encore multiprocessor: Results and analysis, 14:48714 (R;US)
O-RINGS
See GASKETS
OAK RIDGE NATIONAL LABORATORY
See ORNL
OBSIDIANITES
See TEKTITES
OCCUPATIONAL EXPOSURE
Computer system development to support TMI-2 [Three Mile Island Unit 2] radiological controls, operations, and records management activities, 14:47178 (J;US)
Health-hazard evaluation report HETA-87-300-0000, B. F. Goodrich Company, Marietta, Ohio, 14:47944 (R;US)
Occupational hazards of laser-material processing. Final report, 1 October 1972-31 January 1975, 14:47939 (R;US)
Walk-through survey report, Gulfstream American Corporation (formerly Grumman-American Aviation Corp.) Savannah, Georgia, 14:47956 (R;US)
OCTANE
A detailed chemical kinetic reaction mechanism for the oxidation of iso-octane and n-heptane over an extended temperature range and its application to analysis of engine knock, 14:47619 (BA;US)
Calculations of unsteady reacting droplet flows, 14:47703 (BA;US)
JSFR (Jet Stirred Flow Reactor) combustion processes of n-heptane and isooctane, 14:47682 (BA;US)
OFFICE BUILDINGS
Evaluating office lighting environments: Second-level analysis, 14:47273 (R;US)
OFFSHORE DRILLING
Outer Continental Shelf environmental assessment program. Final reports of principal investigators. Volume 58, 14:46899 (R;US)
OFFSHORE PLATFORMS
Preliminary assessment of offshore platform conversion to geothermal power station, 14:47052 (R;GB)
OIL SAND DEPOSITS
Behavior of combustible liquid soaked in porous beds during flame spread, 14:46922 (BA;US)
OIL SANDS
Characterization of sorbed oil components on clays and quartz grains in oil sand. A contribution to the wettability of reservoir rocks in petroleum deposits, 14:46920 (R;DE;In German)
OIL SHALE DEPOSITS
Behavior of combustible liquid soaked in porous beds during flame spread, 14:46922 (BA;US)
OIL SHALE PROCESSING PLANTS
Parachute Creek Shale Oil Program. Environmental monitoring plan, Annual report, October 1, 1987-September 30, 1988, 14:46924 (R;US)
OIL SHALE WASTE WATER
See OIL SHALES
WASTE WATER
OIL SHALES
Eastern oil shale research involving the generation of retorted and combusted oil shale solid waste, shale oil collection, and process stream sampling and characterization: Final report, 14:46923 (R;US)
[Combustion tests of sample Jordan oil shale, Karhula, Finland, and visit to Espoo, Finland, January 14–20, 1988]: Foreign trip report, 14:46921 (R;US)
OIL SPILL FINGERPRINTING
See OIL SPILLS
OIL SPILLS
Fate and transport of petroleum released from leaking underground-storage tanks in areas of karst topography. Technical report, 14:46900 (R;US)
Field evaluation of a soil-gas analysis method for detection of subsurface petroleum hydrocarbon contamination, 14:47983 (RA;US)
OIL WELLS
A laboratory investigation of foam flow in sandstone at elevated pressure, 14:46894 (BA;US)
Fracture characteristics and reservoir behavior of stress-sensitive fracture systems in flat-lying lenticular formations, 14:46896 (J;US)
Steam-zone electrical characteristics for geodiagnostic evaluation of steamflood performance, 14:46895 (BA;US)
OMEGA-1778 RESONANCES
See MESONS
ON-LINE COMPUTERS
See COMPUTERS
ON-LINE MEASUREMENT SYSTEMS
On-line testing of PARR instrumentation by plant computer, 14:47121 (R;PK)
ONE-DIMENSIONAL CALCULATIONS
Structure of a boundary layer in a system of Brownian particles, 14:48261 (RA;AT;In German)
OPE MODEL
A consistent meson-theoretical model of the nucleon-antinucleon interaction, 14:48356 (R;DE;In German)
OPTICAL ANTIPODES
See ENANTIOMORPHS
OPTICAL EQUIPMENT
Design and performance of an optical mount using cross-flexure pivots, 14:47728 (R;US)
OPTICAL SPECTROMETERS
Determination of relative number density and decay rate for atomic sodium in an atmospheric premixed flame by Asynchronous Optical Sampling, 14:47468 (BA;US)
ORGANIC CHLORINE COMPOUNDS
Chemical structure of fuel-rich, premixed, laminar flames of trichloroethylene, 14:47664 (BA;US)
Kinetics of the reactions of chlorinated alkynes with atomic oxygen: The application of a new experimental technique, 14:47920 (BA;US)
ORGANIC COMPOUNDS
Cost and performance of membranes for organic control in small systems: Flagler Beach and Punta Gorda, Florida. Final report, 1 June 1986-28 February 1989, 14:48038 (R;US)
Environmental studies in support of the live fire training facilities project, 14:48028 (R;US)
Information collection request for proposed National Primary Drinking Water Regulations for synthetic organic chemicals (draft), April 1989, 14:48072 (R;US)
Remedial investigation of the High Explosives Burn Pit facility, Building 829 complex, Lawrence Livermore National Laboratory site 300, 14:47862 (R;US)
Simulation of the low earth orbital atomic oxygen interaction with materials by means of an oxygen ion beam, 14:47439 (R;US)
Stability of volatile organics in environmental water samples: Storage and preservation: Final report, 14:48029 (R;US)

Technologies and costs for the removal of synthetic organic chemicals from potable-water supplies. Appendix A: Estimation of carbon usage rates, March 1989, 14:48044 (R;US)
Treatability of hazardous chemicals in soils: Volatile and semivolatile organics, 14:48143 (R;US)

ORGANIC NITROGEN COMPOUNDS
Cyclopentane formation in the reduction of 1,5-dihaloalkanes with a nickel(I) macrocycle, 14:47023 (J;US)
Photodynamics of a nickel hydrocorphinoid model of F_{430}, 14:47022 (J;US)
Preparation, properties, and crystal structure of a novel series of macrocyclic organocobalt complexes, 14:47533 (J;US)
Unusually rapid homolysis of the cobalt-carbon bond in a macrocyclic benzylcobalt complex, 14:47532 (J;US)

ORGANIC POLYMERS
Chemical phenomena in solid-state voltammetry in polymer solvents, 14:47535 (J;US)

ORGANIC SOLVENTS
Health-hazard evaluation report HETA-87-300-0000, B. F. Goodrich Company, Marietta, Ohio, 14:47944 (R;US)
Isolation and identification of microorganisms capable of degrading common laboratory solvents, 14:47224 (RA;US)
Safety demonstration test on solvent fire in fuel reprocessing plant, 14:46932 (R;JP;In Japanese)

ORGANOMETALLIC COMPOUNDS
Preparation, properties, and crystal structure of a novel series of macrocyclic organocobalt complexes, 14:47533 (J;US)
Unusually rapid homolysis of the cobalt-carbon bond in a macrocyclic benzylcobalt complex, 14:47532 (J;US)
Utility of cyclodichlorophosphazene as a NaC_5H_5 scavenging reagent: Synthesis of an organoyttrium hydroxide complex and the x-ray crystal structure of the layered compound $((C_5H_5)_2Y(\mu\text{-}OH))_2$ $(C_6H_5C{\equiv}CC_6H_5)$, 14 : 47531(*J; US*)

ORNL
Assessment of potential worker exposure during the operational phase of the Tumulus disposal demonstration project, 14:46950 (RA;US)
Chemistry Division annual progress report for period ending March 31, 1989, 14:47460 (R;US)
Data and information management system for the ORNL (Oak Ridge National Laboratory) Remedial Action Program, 14:46999 (RA;US)
Hydrogeology of Melton Valley determined from hydraulic head measuring station data, 14:48027 (R;US)
ORNL (Oak Ridge National Laboratory) implementation of New Health and safety requirements (DOE (Department of Energy) Order 5480.11), 14:46987 (RA;US)
Research organization: Environmental Sciences Division, Oak Ridge National Laboratory, 14:47985 (R;US)
Technology applications bulletins: Number one, 14:47243 (R;US)

OSCILLATIONS (PLASMA)
See PLASMA WAVES

OSCILLATORS
Lyapunov stability of large systems of van der Pol-like oscillators and connection with statistics and turbulence, 14:48515 (R;DE)

OSMIUM 170
Band crossing in ^{170}Os, 14:48453 (R;AU)

OSMIUM ISOTOPES
Causes for geographical variations in OS187/OS186 at the Cretaceous-Tertiary boundary, 14:48210 (RA;US)
[Collective properties of light tungsten and osmium nuclei]: Foreign trip report, July 24, 1988–July 29, 1988, 14:48480 (R;US)

OVERBURDEN
Estimation of the bulk diffusivity of chimneys using post-shot holes, 14:47904 (RA;US)

OXIDANTS
See OXIDIZERS

OXIDASES
See OXIDOREDUCTASES

OXIDIZERS
Study of molecular mixing and a finite rate chemical reaction in a mixing layer, 14:47577 (BA;US)

OXIDIZING AGENTS
See OXIDIZERS

OXIDOREDUCTASES
Temperature-dependent enantiospecificity of secondary alcohol dehydrogenase from Thermoanaerobacter ethanolicus, 14:47530 (J;US)

OXIRANS
See EPOXIDES

OXYGEN
An HTP kinetics study of the reaction of $O(^3P)$ atoms with propylene over the 300 to 1215 K temperature range, 14:47536 (BA;US)
Antioxidant mechanisms in radiation injury and radioprotection, 14:48118 (R;US)
Discussion of two-photon laser-excited fluorescence as a method for quantitative detection of oxygen atoms in flames, 14:47467 (BA;US)
High temperature study of the reaction of $O(^3P) + NH_3$, 14:47482 (R;US)
Kinetics of the reactions of unsaturated free radicals (methylvinyl and $i\text{-}C_4H_3$) with molecular oxygen, 14:47625 (BA;US)
Measurement of angular differential cross sections at the SSL Atomic Scattering Facility, 14:48274 (RA;US)
Primary products of the reaction between $O(^3P)$-atoms and C_2H_4 studied with ESR- and LMR-detection, 14:47537 (BA;US)
Reactions of hydroxymethyl and hydroxyethyl radicals with molecular and atomic oxygen, 14:47626 (BA;US)
The reactions of benzyl radicals with hydrogen atoms, oxygen atoms, and molecular oxygen using EI/REMPI mass spectrometry, 14:47632 (BA;US)
The roles of innate oxygen and adsorbed oxygen in the chemistry of soot oxidation by oxygen atoms at 298 K, 14:47575 (BA;US)

OXYGEN 16 BEAMS
[The first WA80 production run with ^{16}O nuclei at ultrarelativistic energies]: Foreign trip report, November 4, 1986–December 11, 1986, 14:47796 (R;US)

OXYGEN 16 REACTIONS
Pion interferometry of O+Au at 200 AGeV, 14:48486 (J;NL)
Some TPC measurements in an oxygen beam at the AGS, 14:47839 (J;NL)

OXYGEN 18
Progressive mineral alteration and coupled ^{18}O depletions in the Lake City hydrothermal system (23 Ma), Colorado, 14:47061 (RA;US)

OXYGEN EFFECT (RADIOBIOLOGY)
See OXYGEN

OXYGEN HYDRIDES
See WATER

OXYGEN ISOTOPES
Development and application of stable isotope mass transfer reaction path models, 14:47058 (RA;US)

OXYMETHYLENE
See FORMALDEHYDE

OZONE
Injury and yield response of cotton to chronic doses of ozone and soil-moisture deficit, 14:48153 (R;US)
Ozone depletion, greenhouse gases, and climate change: Proceedings, 14:47924 (R;US)
Spark ignition of methane and methanol in ozonized air, 14:46916 (BA;US)

1,2,4,5-TETRAMETHYLBENZENE
See DURENE

1,2-ETHANEDIOL
See GLYCOLS

1,3,5-TRIAMINO-2,4,6-TRINITROBENZENE
See TATB

1-DIMENSIONAL CALCULATIONS
See ONE-DIMENSIONAL CALCULATIONS

1-PROPANOL
See PROPANOLS

P

P CODES
Computational fluid dynamics assessment: Volume 1, Computer simulations of the METC [Morgantown Energy Technology Center] entrained-flow gasifier: Final report, 14:46815 (R;US)

P INVARIANCE
Spontaneous parity breaking by quantum corrections, 14:48328 (RA;PL)

P WAVES (SEISMIC)
See SEISMIC P WAVES

P-N JUNCTIONS
Change of p-n junction photoelectric properties during semiconductor transition in to ferroelectric phase, 14:48514 (RA;SU;In Russian)

PACEMAKERS
See CARDIAC PACEMAKERS

PACIFIC OCEAN
[Collection of North Pacific Ocean surface seawater samples from a container ship]: Foreign trip report, January 24–March 4, 1989, 14:47931 (R;US)

PADUCAH PLANT
Summary of findings on evaluation of aqueous degreasers versus chlorinated solvents at the Paducah Gaseous Diffusion Plant, 14:46940 (RA;US)

PAH
See POLYCYCLIC AROMATIC HYDROCARBONS

PAINTS
Paint coatings: Controlled field and chamber experiments, 14:47947 (R;US)
Walk-through survey report, Gulfstream American Corporation (formerly Grumman-American Aviation Corp.) Savannah, Georgia, 14:47956 (R;US)
[Discussion of plastic media blasting]: Foreign trip report, 1988, 14:47289 (R;US)

PAIR PRODUCTION
On production of supersymmetric Majorana particles in polarized e^+e^- collisions, 14:48337 (RA;PL)

PAIR SPECTROMETERS
Photon detector for MEGA: Progress report, July 15, 1988–May 1, 1989, 14:47824 (R;US)

PAKISTAN ATOMIC RESEARCH REACTOR
See PARR REACTOR

PALLADIUM
Calculations of resistivity and superconducting T_c in transition metals, 14:48536 (BA;US)
Reaction rates in cold fusion, 14:48676 (RA;AT;In German)
Search for crystal-catalyzed fusion reactions, 14:48674 (RA;AT;In German)

PAPER INDUSTRY
A comprehensive program to develop correlations for the physical properties of kraft black liquors, 14:47283 (R;US)
Water-pollution abatement expenditures in the Wisconsin paper industry. Technical report, 14:48037 (R;US)

PARAFFINS
See ALKANES

PARALLEL PROCESSING
3D (three-dimensional) Navier-Stokes flow analysis for a large-array multiprocessor. Final technical report, 14 September 1988-29 February 1989, 14:48283 (R;US)
BM/C(3) algorithm mapping onto concurrent processors. Final report, May-December 1987, 14:48719 (R;US)
High-speed parallel-processing networks for advanced architectures, 14:48720 (R;US)
Laboratory for Computer Science progress report 24, July 1986-June 1987, 14:48716 (R;US)
Memory-reference characteristics of multiprocessor applications under MACH, 14:48713 (R;US)
Parallel implementation of OPS5 on the Encore multiprocessor: Results and analysis, 14:48714 (R;US)
Parallel version of the Boyer-Moore prover. Technical report, 14:48712 (R;US)
Programming language supporting first-class parallel environments. Technical report, 14:48718 (R;US)
Suitability of message-passing computers for implementing production systems, 14:48715 (R;US)
Supercomputers, architectures and applications, 14:48734 (R;NL;In Dutch)

PARAMAGNETIC RESONANCE (ELECTRON)
See ELECTRON SPIN RESONANCE

PARAMAGNETIC RESONANCE (NUCLEAR)
See NUCLEAR MAGNETIC RESONANCE

PARASYMPATHOMIMETICS
Influence of pyridostigmine on the antiemetic effect of domperidone in irradiated macaques, 14:48137 (RA;FR;In French)
Influence of the association pyridostigmine-gamma irradiation (15 Gy) on the physical performances of the macacus cynomolgus, 14:48138 (RA;FR;In French)

PARITY NONCONSERVATION
See P INVARIANCE

PARR REACTOR
Development of on-line reactivity meter for PARR, 14:47112 (R;PK)
On-line testing of PARR instrumentation by plant computer, 14:47121 (R;PK)
Preliminary radiological consequence estimate for a reference LEU core for PARR, 14:47117 (R;PK)

PARTIAL DIFFERENTIAL EQUATIONS
Domain decomposition for partial differential equations, 14:48736 (R;US)

PARTICLE BEAMS
Beam profile effects on NPB performance, 14:47795 (R;US)

PARTICLE-BEAM WEAPONS
See DIRECTED-ENERGY WEAPONS

PARTICLES
Particle rotation in coal combustion: Statistical, experimental and theoretical studies, 14:46856 (BA;US)

PARTICLES (FUEL)
See FUEL PARTICLES

PARTICULATES
Chemical Mass Balance (CMB) Receptor Model (Version 6.0) (for microcomputers). Model-Simulation, 14:47935 (R;US)
Development of sampling methods for source PM10 emissions. Final report, 14:47951 (R;US)
Nested-fiber filter for high-temperature and high-pressure particulate removal: Final report, 14:46840 (R;US)
Polycyclic aromatic hydrocarbons, particulates, and defense mechanisms (VKC-BAB-145). Final report, 14:47945 (R;US)
Second review of new source performance standards for coal preparation plants. Final report, 14:46841 (R;US)
Stationary combustion: The environmental leitmotiv, 14:46846 (BA;US)

PCB
See CHLORINATED AROMATIC HYDROCARBONS

PEAT
Composting of surface peat, waste water sludge and bark, the properties and suitability of substietes for growing media for landscaping, 14:47038 (R;FI;In Finnish)
Experiments on the combustion of small peat particles in an entrained-flow, isothermal furnace. Research note, 14:46883 (R;FI)
Isotopic investigations in the area of the Tunguska catastrophe in 1908 year, 14:48200 (RA;US)
Microbial solubilization of peat for production of synthetic fuels, 14:46805 (RA;US)
Uptake of radiocaesium by upland herbaceous vegetation in relation to soil type, 14:47988 (R;GB)
Use of surface peat in growing media for landscaping and public gardens in Northern Finland, 14:47039 (R;FI;In Finnish)

PEATLANDS
See WETLANDS

PEBBLE BED REACTORS
Reference elements for irradiation testing under THTR-follow-up plant conditions to determine safe fission product retention. Final report, 14:47097 (R;DE;In German)

PENETRATION DEPTH
Influence of fluctuations on the phase transformations in the superconductor, 14:47358 (RA;AT;In German)

PENETRATORS
Measurement of in situ strength using projectile penetration: Tests of a new launching system, 14:47897 (RA;US)

PENICILLIUM
Comparison of alkali and microbial solubilization of oxidized, low-rank coal, 14:46803 (RA;US)

PENNING DISCHARGES
Investigation of r-f emissions from electric-field-dominated plasmas. Final scientific report, 31 January 1980-31 March 1989, 14:48282 (R;US)

PENNSYLVANIA
Emergency response planning in Pennsylvania, 14:47185 (J;US)

PENTANOLS
Temperature-dependent enantiospecificity of secondary alcohol dehydrogenase from Thermoanaerobacter ethanolicus, 14:47530 (J;US)

PENTYL ALCOHOLS
See PENTANOLS

PEOPLE
See HUMAN POPULATIONS

PEOPLES REPUBLIC OF CHINA
See CHINA

PERCHLORATES
Pressure-induced spin-state interconversion of (Fe(6-Me-py)$_3$tren)(ClO$_4$)$_2$ in solution, 14:47527 (J;US)

PERFORMANCE TESTING
Performance assessment for future low-level waste disposal facilities at ORNL, 14:46958 (R;US)

PERHYDROXYL RADICAL
See HYDROPEROXY RADICALS

PERMANENT MAGNETS
Liquid Dynamic Campaction of Fe-Nd-B permanent magnets. Final report, 1 September 1984-31 December 1988, 14:47327 (R;US)
Method of mass-producing superconducting persistent current rings, 14:47736 (P;US)
Method of transforming a passive ferromagnetic material into a permanent magnet, 14:47735 (P;US)
Superconducting shielded PYX PPM (periodic permanent magnet) stacks, 14:47734 (P;US)

PEROVSKITE CRYSTAL STRUCTURE
See CUBIC LATTICES

PEROXYACETYL NITRATE
Southern California Air Quality Study: Peroxyacetyl nitrate (PAN) measurements. Final report, 14:47941 (R;US)

PERSONAL COMPUTERS
Implementation of a customizable instruction editing and delivery system, 14:48721 (R;US)

PERSONNEL
Control of the TMI-2 [Three Mile Island Unit 2] reactor building environment, 14:47183 (J;US)
Dosimetry studies pertaining to the accident at TMI-2 [Three Mile Island Unit 2], 14:47179 (J;US)
Personnel contamination protection techniques applied during the TMI-2 [Three Mile Island Unit 2] cleanup, 14:47182 (J;US)
The role of radiation instruments in the recovery of TMI-2 [Three Mile Island Unit 2], 14:47184 (J;US)
Training requirements for preparing hazardous waste site workers for involvement with mixed waste, 14:46988 (RA;US)
University programs in waste management research, education, and training, 14:46989 (RA;US)
Worker exposures during the TMI-2 [Three Mile Island Unit 2] recovery, 14:47180 (J;US)

PERSONNEL DOSIMETRY
Development of a dose algorithm for the modified panasonic UD-802 personal dosimeter used at three mile island, 14:47176 (J;US)
Hanford radiological protection support services annual report for 1988, 14:47837 (R;US)

PERSONNEL FILM DOSIMETRY
See PERSONNEL DOSIMETRY

PETROCHEMICAL PLANTS
Superfund Record of Decision (EPA Region 6): French Limited, Texas (first remedial action), March 1988. Final report, 14:48008 (R;US)

PETROLEUM
Combustion efficiency, radiation, CO and soot yield from a variety of gaseous, liquid, and solid fueled buoyant diffusion flames, 14:46902 (BA;US)
Estimating air-toxics emission from coal and oil combustion sources. Final report, 14:47953 (R;US)
Interactive chemistry of coal-petroleum processing: Quarterly report, March 16, 1989–June 15, 1989, 14:46898 (R;US)
Kinetics and quantitative analysis of the isomerization and aromatization of fossil steroid hydrocarbons within experiments and in naturally matured sample sequences, 14:46889 (R;DE;In German)
Laboratory study of nitrogen miscible displacement of light oil, 14:46892 (R;US)
MMV figures on petroleum 1988, 14:47253 (R;DE;In German)
Outer Continental Shelf environmental assessment program. Final reports of principal investigators. Volume 58, 14:46899 (R;US)
[National Institute for Petroleum and Energy Research] 1988 annual report, 14:46893 (R;US)

PETROLEUM COKE
See PETROLEUM PRODUCTS

PETROLEUM DEPOSITS
5-year outer continental shelf oil and gas leasing program, Mid-1987 to Mid-1992: Supplemental environmental impact statement: Draft, 14:48083 (R;US)
Gulf of Mexico Sales 123 and 125: Central and Western Planning Areas: Final Environmental Impact Statement, 14:48082 (R;US)

PETROLEUM PRODUCTS
Fate and transport of petroleum released from leaking underground-storage tanks in areas of karst topography. Technical report, 14:46900 (R;US)
MMV figures on petroleum 1988, 14:47253 (R;DE;In German)
Soot formation in combustion processes, 14:47561 (BA;US)
[National Institute for Petroleum and Energy Research] 1988 annual report, 14:46893 (R;US)

PETROLEUM REFINERIES
Superfund Record of Decision: (EPR Region 6): Curley Pit Site, ground-water operable unit, Crittenden County, Arkansas (second remedial action), September 1988. Final report, 14:48055 (R;US)

PETROLOGY
Mineralogy-petrology studies and natural barriers at Yucca Mountain, Nevada, 14:46970 (R;US)

PH VALUE
Effects of acid and aluminum on swim bladder development and yolk absorption in the fathead minnow, pimephales promelas, (journal version), 14:48146 (R;US)

PHANEROCHAETE
Biological solubilization of coal in aqueous and nonaqueous media, 14:46806 (RA;US)
Microbial solubilization of peat for production of synthetic fuels, 14:46805 (RA;US)

PHANTOMS
Dosimeter readings reproducibility in water phantom measurements at electron accelerators with a beam scanning system, 14:47809 (RA;AT;In German)

PHENANTHRENE
Photoexcited charge pair escape and recombination: Progress report, August 1, 1988–August 1, 1989, 14:47539 (R;US)

PHENYL RADICALS
A shock tube study on the thermal decomposition of toluene and of the phenyl radical at high temperatures, 14:47633 (BA;US)
Reactions of vinyl and phenyl radicals with ethyne, ethene and benzene, 14:47630 (BA;US)

PHOSPHATES
Examination of the function of active site lysine 329 of ribulose-bisphosphate carboxylase/oxygenase as revealed by the proton exchange reaction, 14:48096 (J;US)

PHOSPHINES
Flash photolysis studies of RhCl(CO)L2 (L = trimethyl- or tritolylphosphine). Evidence for intermediates in the photocatalytic carbonylation of hydrocarbons, 14:47541 (J;US)
PHOTOCHROMIC MATERIALS
Analysis and evaluation of technical data on the photochromic and nonlinear optical properties of materials. Quarterly technical report No. 1, 14:48158 (R;US)
Photochromic polymers. January 1973-June 1989 (Citations from the Rubber and Plastics Research Association data base). Report for January 1973-June 1989, 14:47443 (R;US)
PHOTOMAGNETOELECTRIC EFFECT
See MAGNETIC FIELDS
PHOTON-ELECTRON INTERACTIONS
B factory via conversion of 1 TeV electron beams into 1 TeV photon beams, 14:48324 (R;US)
PHOTON-PHOTON INTERACTIONS
Two-photon physics at LEP, 14:48352 (RA;SU)
PHOTON-PROTON INTERACTIONS
Check of colour symmetry at the LEP collider, 14:48353 (RA;SU)
PHOTOSYNTHESIS
[Function of active-site residues of ribulosebisphosphate carboxylase/oxygenase, Stockholm, Sweden, and visit to Uppsala, Sweden, August 6–12, 1989]: Foreign trip report, 14:47037 (R;US)
PHOTOVOLTAIC CONVERSION
Photovoltaic system research status, 14:47040 (R;US)
PHOTOVOLTAIC POWER SUPPLIES
Photovoltaic power supply in 40 remote houses in France, 14:47042 (R;FR;In French)
Starting characteristics of direct current motors powered by solar cells, 14:47043 (R;US)
PHYSICAL EFFORT
See EXERCISE
PHYSICAL RADIATION EFFECTS
Physics of radiation damages and radiation material science. Scientific-technical collection, 14:47359 (R;SU)
PHYSICS
Annual convention 1989 of the Austrian physical society, 14:48172 (R;AT;In German, English)
Experimental and theoretical physics. Collection, 14:48173 (R;SU)
[Cyclotron based nuclear science]: Progress in research, April 1, 1988–March 31, 1989, 14:48245 (R;US)
PHYTOPLANKTON
[North Atlantic seasonal ecosystem model]: Foreign trip report, January 16–21, 1989, 14:48171 (R;US)
PI-1016 RESONANCES
See MESONS
PIEZOMETRY
Multi-component stress history measurements and analysis, 14:47880 (RA;US)
PIG DISCHARGES
See PENNING DISCHARGES
PIGMENT CELLS
See ANIMAL CELLS
PIGS
See SWINE
PILOT PLANTS
A comprehensive program to develop correlations for the physical properties of kraft black liquors, 14:47283 (R;US)
PIMEPHALES PROMELAS
See FATHEAD MINNOW
PION MINUS REACTIONS
Nuclear-target effects in J/psi production in anti p and π^- interactions, 14:48440 (J;NL)
PION MINUS-PROTON INTERACTIONS
Double prompt photon production at high transverse momentum by π^- on protons at 280 GeV/c, 14:48292 (R;US)
PION REACTIONS
Low-energy pion double charge exchange and nucleon-nucleon correlations in nuclei, 14:48475 (R;US)
PION-EXCHANGE MODEL
See OPE MODEL
PIONS
Effective QCD chiral Lagrangian for pions and vector mesons and hidden local symmetry, 14:48326 (R;XA)
On exclusive structure functions and inclusive hadron spectra near X=1, 14:48347 (RA;SU;In Russian)
PIPES
[Discussion of fracture mechanics and testing for reactor pressure components, Stuttgart, W. Germany, May 23–27, 1988]: Foreign trip report, 14:47107 (R;US)
PISTONS
Comparison of computed and measured air motion in circular and square piston cups, 14:47311 (B;US)
PITTSBURGH ENERGY TECHNOLOGY CENTER
[Pittsburgh Energy Technology Center] quarterly technical progress report for the period ending June 30, 1988, 14:46791 (R;US)
PLANETARY ATMOSPHERES
Atmospheric erosion by impacts: An analytic investigation, 14:48211 (RA;US)
PLANETS
High pressure studies of planetary matter, 14:48227 (R;US)
Risk to civilization: A planetary science perspective, 14:48192 (RA;US)
PLANT GROWTH
[Analysis of vegetation responses to changes in the global environment]: Foreign trip report, March 29, 1989–April 7, 1989, 14:47932 (R;US)
[Development of a global vegetation model]: Foreign trip report, February 15–20, 1988, 14:47927 (R;US)
PLANTS
Landscape dynamics in the Arctic foothills: Progress report, July 1, 1988–August 31, 1989, 14:47972 (R;US)
Uptake of radiocaesium by upland herbaceous vegetation in relation to soil type, 14:47988 (R;GB)
Wetland soils and vegetation, Arctic Foothills, Alaska, 14:47973 (R;US)
PLANTS (PILOT)
See PILOT PLANTS
PLANTS (POWER)
See POWER PLANTS
PLASMA
17th AINSE plasma physics conference: conference handbook, 14:48581 (R;AU)
Antenna coupling calculations for BASIL II, 14:48639 (RA;AU)
Experimental studies of parametric decay instability in the WOMBAT apparatus, 14:48638 (RA;AU)
Fast anisotropic etching of silicon by SF_6 in an inductively coupled plasma reactor, 14:48505 (RA;AU)
Impact transport of reaction products in magnetized fusion plasmas, 14:48592 (RA;AT;In German)
Linear systems description of forward scattering experiments, 14:48611 (RA;AU)
Optical gain in BASIL II at the lower hybrid resonance, 14:48605 (RA;AU)
RF plasmas and impurity effects, 14:48623 (RA;AU)
Recent advances in plasma processing, 14:48598 (RA;AU)
Scattering from Alfven waves using a gyrotron, 14:48637 (RA;AU)
Spectroscopic and image intensified investigations of low temperature DC and RF plasma in N_2, 14:48603 (RA;AU)
Temporal and spatial filtering remedies for dispersion in electromagnetic particle codes, 14:48663 (R;US)
Toroidal parallel flow in Tokamaks, 14:48589 (RA;AT;In German)
Transverse oscillating field current drive in spherical plasmas, 14:48613 (RA;AU)
PLASMA CENTRIFUGES
Isotope separation in the vacuum arc centrifuge, 14:47011 (RA;AU)
PLASMA CONFINEMENT
Limiter H-modes in the JIPP T-IIU tokamak, 14:48650 (R;JP)
Magnetic confinement - status and prospects, 14:48615 (RA;AU)
Plasma diffusion in an inductively coupled RF plasma etching system, 14:48606 (RA;AU)

PLASMA DIAGNOSTICS
Gyrotron IV - a new tunable gyrotron for plasma diagnostics, 14:48621 (RA;AU)
Novel interferometric methods in plasma diagnostics, 14:48591 (RA;AT;In German)
Review of techniques for fluctuation measurements, 14:48617 (RA;AU)
Submillimetre laser scattering from TORTUS, 14:48616 (RA;AU)

PLASMA FLUID EQUATIONS
Toroidal parallel flow in Tokamaks, 14:48589 (RA;AT;In German)

PLASMA HEATING
Collective processes with energetic particles in fusion plasmas, 14:48590 (RA;AT;In German)

PLASMA INSTABILITY
Generalization of the Newcomb equation to Hamiltonian form, 14:48629 (RA;AU)
Localised co-interchange instabilities in a rotamak plasma, 14:48627 (RA;AU)

PLASMA OSCILLATIONS
See PLASMA WAVES

PLASMA SHEET
Collisionless tearing instability of a bi-Maxwellian neutral sheet with exact particle orbits. Interim report, 14:48583 (R;US)
Computer simulations of electromagnetic ion instabilities in the plasma sheet boundary layer, 14:48241 (R;US)
Multipoint measurements from substorm onset to recovery: The relation between magnetic pulsations and plasma-sheet thickening, 14:48236 (R;US)

PLASMA SIMULATION
An electromagnetic finite element particle code on an unstructured grid, 14:48662 (R;US)
Image simulation using LOCUS, 14:48660 (R;US)
New 1D-3V spherically symmetric PIC code, 14:48268 (RA;AU)
Simulation of a RF parallel plate discharge, 14:48599 (RA;AU)

PLASMA SWITCHES
ANTHEM simulation of plasma opening switches, 14:47201 (R;US)
Launched electrons in plasma opening switches, 14:48691 (R;US)

PLASMA WAVES
On lower hybrid wave scatteing by plasma density fluctuation. Nonlinear reflection coefficient of the fast magnetoacoustic wave, 14:48645 (R;CS)

PLASMASPHERE
Short wavelength striations on expanding plasma clouds, 14:48242 (R;US)

PLASTER OF PARIS
See GYPSUM CEMENTS

PLATES
[Discussion of fracture mechanics and testing for reactor pressure components, Stuttgart, W. Germany, May 23–27, 1988]: Foreign trip report, 14:47107 (R;US)

PLATINUM
Polymerization and decarbonylation reactions of aldehydes on the Pd(111) surface, 14:47528 (J;US)

PLATINUM 194
Possible discontinuity in octupole behaviour in the Pt-Hg region, 14:48455 (R;AU)

PLATINUM 196
Possible discontinuity in octupole behaviour in the Pt-Hg region, 14:48455 (R;AU)

PLATINUM 198
Possible discontinuity in octupole behaviour in the Pt-Hg region, 14:48455 (R;AU)

PLATINUM CHLORIDES
Low severity coal conversion by ionic hydrogenation: Progress report, May–July 1989, 14:46819 (R;US)

PLESIOTHERAPY
See RADIOTHERAPY

PLOWS (COAL)
See COAL PLOWS

PLUGS
See CLOSURES

PLUTONIUM
Non-destructive measurements of water reactor fuel and evaluation of measurement techniques for improved assay accuracy, 14:47092 (RA;XA)
Risk of plutonium: Estimate and control. Biological background and organizational-technical measures, 14:48129 (R;DE;In German)

PLUTONIUM 242
Actual experience in burnup determination of mixed oxide fuel, 14:47477 (RA;XA)

PLUTONIUM DIOXIDE
Studies of the conversion-chemistry of plutonium and uranium in the nitrate- and carbonate-systems. Final report, 14:47548 (R;DE;In German)

PLUTONIUM NITRATES
Studies of the conversion-chemistry of plutonium and uranium in the nitrate- and carbonate-systems. Final report, 14:47548 (R;DE;In German)

PLUTONYL COMPOUNDS
Studies of the conversion-chemistry of plutonium and uranium in the nitrate- and carbonate-systems. Final report, 14:47548 (R;DE;In German)

PMMA
Effects of thermal stability and melt viscosity of thermoplastics on piloted ignition, 14:47654 (BA;US)

PNA
See POLYCYCLIC AROMATIC HYDROCARBONS

PNEUMOCONIOSES
Pneumoconiosis in coal miners and exposure to dust of variable quartz content. Final report, December 1985-May 1988, 14:46887 (R;GB)

POISONS (CHEMICAL)
See HAZARDOUS MATERIALS

POLAR REGIONS
Origin of density enhancements in the winter polar-cap ionosphere, 14:48233 (R;US)

POLLUTANTS
Technologies and costs for the treatment and disposal of waste byproducts from water treatments for the removal of inorganic and radioactive contaminants (revised draft), September 1986, 14:48040 (R;US)

POLLUTION CONTROL
Local implementation by New England municipalities of the Emergency Planning and Community Right-To-Know Act of 1986 (Title 3 of SARA) (Superfund Amendments and Reauthorization Act). Technical report (Final), 14:47228 (R;US)

POLLUTION REGULATIONS
Use of a Monte Carlo modeling approach for evaluating risk and environmental compliance, 14:47220 (RA;US)

POLONIUM 218
The half-life of ^{218}Po, 14:48140 (J;US)

POLY(ISOBUTYLENE OXIDE)
See EPOXIDES
ORGANIC POLYMERS

POLY(VINYLIDENE FLUORIDE)
See FLUORINATED ALIPHATIC HYDROCARBONS
POLYVINYLS

POLYACETYLENES
3-D structures and intrinsic defects in trans-polyacetylene, 14:47431 (R;US)

POLYACRYLONITRILE
See ORGANIC POLYMERS

POLYATOMIC MOLECULES
New developments in the ab initio treatment of low energy electron collisions with molecules, 14:48272 (R;US)

POLYCRYSTALS
High-temperature superconductors: physical properties of single crystalline- and polycrystalline samples, and of thin films, 14:47423 (RA;AT;In German)
Microstructural dynamic study of grain growth, 14:48537 (BA;US)

POLYCYCLIC AROMATIC HYDROCARBONS
On the driving force of PAH (polycyclic aromatic hydrocarbons) production, 14:47635 (BA;US)

Polycyclic aromatic hydrocarbons, particulates, and defense mechanisms (VKC-BAB-145). Final report, 14:47945 (R;US)
Pyrolysis-induced changes in the ring number composition of polycyclic aromatic compounds from a high volatile bituminous coal, 14:46855 (BA;US)
The behavior of polycyclic aromatic hydrocarbons during the early stages of soot formation, 14:47563 (BA;US)

POLYCYCLIC SULFUR HETEROCYCLES
Microbial degradation of organosulfur compounds: Implications for the microbial desulfurization of coal, 14:46809 (RA;US)

POLYESTERS
Degradation and crosslinking of perfluoroalkyl polyethers under X-ray irradiation in ultrahigh vacuum, 14:47543 (R;US)

POLYETHERS
See POLYETHYLENE GLYCOLS

POLYETHYLENE GLYCOLS
Roles of additives and surface control in slurry atomization: Quarterly report, 14:46833 (R;US)

POLYETHYLENE OXIDES
See POLYETHYLENE GLYCOLS

POLYETHYLENE TERPHTHALATE
See POLYESTERS

POLYETHYLENES
Effect of volatility on dust flammability limits for coals, gilsonite, and polyethylene, 14:46842 (BA;US)
Shock induced dissociation of polyethylene, 14:47433 (R;US)
The compatibility of various polymeric liner and pipe materials with simulated double-shell slurry feed at 90°C: Hanford Grout Technology Program, 14:46933 (R;US)

POLYMERS
Analysis and evaluation of technical data on the photochromic and nonlinear optical properties of materials. Quarterly technical report No. 1, 14:48158 (R;US)
Compressive properties of high-performance polymeric fibers. Interim report, April-December 1988, 14:47412 (R;US)
Photochromic polymers. January 1973-June 1989 (Citations from the Rubber and Plastics Research Association data base). Report for January 1973-June 1989, 14:47443 (R;US)
Polyelectrolyte-diffused zinc phosphate conversion coatings and polyacid coupling primers for corrosion protection of steel and aluminum, and alkali-catalyzed hydrolysis of polyimide-based materials: Final report, 14:47414 (R;US)

POLYMETHYLMETHACRYLATES
See PMMA

POLYNOMIALS
On some integral relations involving a generalized hypergeometric polynomial, 14:48551 (R;XA)

POLYNUCLEAR AROMATIC HYDROCARBONS
See POLYCYCLIC AROMATIC HYDROCARBONS

POLYPROPYLENE
The compatibility of various polymeric liner and pipe materials with simulated double-shell slurry feed at 90°C: Hanford Grout Technology Program, 14:46933 (R;US)

POLYSTYRENE
Effects of thermal stability and melt viscosity of thermoplastics on piloted ignition, 14:47654 (BA;US)

POLYTETRAOXANE
See ORGANIC POLYMERS

POLYTHENE
See POLYETHYLENES

POLYURETHANES
Combustion efficiency, radiation, CO and soot yield from a variety of gaseous, liquid, and solid fueled buoyant diffusion flames, 14:46902 (BA;US)
Polyelectrolyte-diffused zinc phosphate conversion coatings and polyacid coupling primers for corrosion protection of steel and aluminum, and alkali-catalyzed hydrolysis of polyimide-based materials: Final report, 14:47414 (R;US)
The compatibility of various polymeric liner and pipe materials with simulated double-shell slurry feed at 90°C: Hanford Grout Technology Program, 14:46933 (R;US)

POLYVINYLS
The SANDIA standard for PVDF [polyvinylidene di-fluoride] shock sensors, 14:47444 (R;US)

POPULATION DYNAMICS
Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (South Atlantic): Black sea bass, 14:48014 (R;US)
Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest): Pile perch, striped seaperch, and rubberlip seaperch, 14:48016 (R;US)
Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (North and Mid-Atlantic): Blue mussel, 14:48015 (R;US)

POROUS MATERIALS
An integration path for the carbon-oxygen reaction with internal reaction, 14:47560 (BA;US)
Behavior of combustible liquid soaked in porous beds during flame spread, 14:46922 (BA;US)

PORTABLE EQUIPMENT
Hanford radiological protection support services annual report for 1988, 14:47837 (R;US)

PORTS
See HARBORS

POSITRON SOURCES
On a possibility of high-power pulsed source for e^-e^+ production on the base of laser fusion device, 14:47810 (RA;SU;In Russian)
TEPOS workshop: Positron sources, 14:47014 (R;DE;In German)

POSITRONS
Positron annihilation radiation in high-temperature superconductors, 14:47827 (RA;AT;In German)

POTABLE WATER
See DRINKING WATER

POTASSIUM
Promotion of char oxidation by inorganic constituents, 14:46849 (BA;US)

POTASSIUM COMPOUNDS
Preparation and characterization of single phase $Ba_{1-x}K_xBiO_3$, 14:47405 (R;US)

POTASSIUM PHOSPHATES
Inclusion tuning of nonlinear optical materials: Sorbates in the KTP structure, 14:47529 (J;US)

POTASSIUM TUNGSTATES
Correlation studyj of the structure and spectroscopic characteristics of coordination compounds of double tungstates of alkali and rare earth elements, 14:47520 (RA;SU;In Russian)

POTENTIAL BARRIERS
See POTENTIALS

POTENTIALS
Optimized perturbation series for the effective potential in PHI^4 field theory, 14:48397 (RA;PL)

POWDERS
Powder morphology effects in the ignition of titanium-based pyrotechnics, 14:47860 (R;US)

POWER GENERATION
Bibliography of the Maryland Power Plant and Environmental Review Division, tenth edition, 14:47256 (R;US)

POWER METERS
Error analysis in the determination of the power performance of wind energy conversion systems, 14:47068 (R;NL)

POWER PLANTS
Air quality studies in the western United States, 14:47925 (R;US)
Report on on-line pulverized coal flow meters, 14:47079 (R;FI;In Finnish)
Service life assesment and examination of concrete structures in renovation, 14:47075 (R;FI;In Finnish)

POWER REACTORS
Emergency environmental monitoring practices at U.S. nuclear power reactor sites, 14:47160 (BA;US)
Use of probabilistic risk assessment (PRA) in expert systems to advise nuclear plant operators and managers, 14:47157 (BA;US)

POWER SUBSTATIONS
Substation evaluation using Diagnostic Logic System (DIALOG), 14:47081 (R;US)

POWER SYSTEMS
Restrictive loads powered by separate or by common electrical sources, 14:47044 (R;US)
POWER TRANSMISSION LINES
Bibliography of the Maryland Power Plant and Environmental Review Division, tenth edition, 14:47256 (R;US)
EMI [electromagnetic interference] potential of proposed 115KV line near B-691, 14:47842 (R;US)
PRASEODYMIUM COMPLEXES
Laser spectroscopy of rare earth (3) ion complexes with inorganic anions in nonaqueous solutions, 14:47507 (RA;SU;In Russian)
PRECAMBRIAN ERA
Evidence for and implications of an Early Archean terrestrial impact record, 14:48201 (RA;US)
PRECIPITATIONS (ATMOSPHERIC)
See ATMOSPHERIC PRECIPITATIONS
PRESSURE GAGES
CORNUCOPIA cavity pressure measurement, 14:47900 (RA;US)
Fluid dynamics of a pressure measuring system for underground explosive tests, 14:47899 (RA;US)
Stress measurements with the sea Calip gauge, 14:47882 (RA;US)
Theoretical and experimental analyses of in-situ gauge inclusion effects, 14:47881 (RA;US)
PRESSURE VESSELS
Disassembly and defueling of the upper core support assembly, 14:47190 (J;US)
In-vessel remote maintenance of the Compact Ignition Tokamak, 14:48704 (J;US)
Marine transportation and burial of the Shippingport Reactor Pressure Vessel/Neutron Shield Tank (RPV/NST) package, 14:47001 (R;US)
Remote leak detection for the Compact Ignition Tokamak, 14:48705 (J;US)
Using ex-core neutron detectors to estimate fuel quantities in the reactor vessel lower head, 14:47175 (J;US)
PRESSURIZED WATER COOLED MODERATED REACTOR
See PWR TYPE REACTORS
PRESSURIZED WATER REACTORS
See PWR TYPE REACTORS
PRESSURIZERS
Assessment of the RETRAN02/MOD3 and RELAP5/MOD2 pressurizer model, 14:47200 (J;US)
PRINTING AND PUBLISHING INDUSTRY
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PROBABILISTIC ESTIMATION
Data book of the component failure rate stored in the RECORD, 14:47106 (R;JP;In Japanese)
PROBES
A combined oxygen/bubble probe for the study of fluidized bed combustion of volatiles, 14:46871 (BA;US)
The application of synchrotron radiation to microprobe trace element analysis of biological samples, 14:47461 (R;US)
PROCESSING (DATA)
See DATA PROCESSING
PRODUCTION (PAIR)
See PAIR PRODUCTION
PROGRAM MANAGEMENT
Reporting environmental data of known quality, 14:48742 (R;US)
PROGRAMMING LANGUAGES
Programming language supporting first-class parallel environments. Technical report, 14:48718 (R;US)
PROJECT MANAGEMENT
See PROGRAM MANAGEMENT
PROJECTILES
Techniques for recovery of shock-loaded samples, 14:47725 (R;US)
PROJECTION SPARK CHAMBERS
Some TPC measurements in an oxygen beam at the AGS, 14:47839 (J;NL)
PROMINENCES (SOLAR)
See SOLAR PROMINENCES
PROMOTERS
Promoted high-temperature reactions, 14:47620 (BA;US)
PROPAGATION (WAVE)
See WAVE PROPAGATION
PROPANE
A structural study of a propane-oxygen diffusion flame diluted with argon, 14:47662 (BA;US)
Combustion efficiency, radiation, CO and soot yield from a variety of gaseous, liquid, and solid fueled buoyant diffusion flames, 14:46902 (BA;US)
Correlations for smoke points and radiant emission of laminar hydrocarbon diffusion flames, 14:47567 (BA;US)
Experiments on the sooting limits of aerodynamically-strained diffusion flames, 14:47570 (BA;US)
Flame-jet ignition of large fuel-air clouds, 14:47655 (BA;US)
Flammability limits for exhaust gas diluted flames, 14:47673 (BA;US)
Measurements of nitrogen Q-branch foreign gas-broadening coefficients relevant to flames, 14:47464 (BA;US)
Preferential diffusion and concentration modification in sooting counterflow diffusion flames, 14:47569 (BA;US)
Propagation mechanism of quasi-detonations, 14:47689 (BA;US)
Scalar dissipation rates in turbulent jets and jet diffusion flames, 14:47598 (BA;US)
Soot formation in diffusion flames of fuel/oxygen mixtures, 14:47568 (BA;US)
The straining of premixed turbulent flames, 14:47602 (BA;US)
PROPANOLS
Radiance, soot, and temperature interactions in turbulent alcohol fires, 14:47646 (BA;US)
PROPELLANTS
A model for double base propellant combustion, 14:47699 (BA;US)
Conventional weapons demilitarization: A health and environmental effects data base assessment: Methods for estimating multi-pathway exposures to environmental contaminants, Final report, Phase 2, 14:48155 (R;US)
Driving of axial acoustic waves by side-wall stabilized premixed flames, 14:47658 (BA;US)
High pressure combustion characteristics of RDX (cyclotrimethylene trinitramine) based propellants, 14:47700 (BA;US)
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PROPENE
See PROPYLENE
PROPULSION SYSTEMS
Fuel cells for vehicle propulsion applications: A thermodynamic systems analysis, 14:47261 (R;US)
PROPYL ALCOHOLS
See PROPANOLS
PROPYLENE
An HTP kinetics study of the reaction of $O(^3P)$ atoms with propylene over the 300 to 1215 K temperature range, 14:47536 (BA;US)
Correlations for smoke points and radiant emission of laminar hydrocarbon diffusion flames, 14:47567 (BA;US)
PROTECTION
See SAFETY
PROTECTION (RADIATION)
See RADIATION PROTECTION
PROTECTIVE COATINGS
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PROTON MICROPROBE ANALYSIS
Ion microbeam tomography, 14:47480 (J;NL)
PROTON-ANTIPROTON INTERACTIONS
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Correlated particle production in proton-antiproton interactions at c.m. energies from 200 to 900 GeV, 14:48294 (R;DE;In German)
Polarisation effect of the rho-meson in interactions at 5.7, 12, 22.5 GeV/c, 14:48308 (RA;PL)
QCD in UA2, 14:48301 (RA;PL)
Recent results from UAI, 14:48299 (RA;PL)
Search for monojet and multijet events with large missing P_T in the UA2 experiment, 14:48302 (RA;PL)
W^{+-} and Z^0 production in UA2 and tests of the standard model, 14:48300 (RA;PL)
PROTON-NEUTRON INTERACTIONS
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PROTON-NUCLEON INTERACTIONS
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PROTON-PROTON INTERACTIONS
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Hyperon-nucleon final state interaction in a pp -> K^+X experiment and the H_1^+ (2130) S = - 1 strange dibaryon, 14:48348 (R;FR)
PROTONS
On exclusive structure functions and inclusive hadron spectra near X=1, 14:48347 (RA;SU;In Russian)
PSI RESONANCES
See MESONS
PSI-4300 RESONANCES
See MESONS
PSYCHOACTIVE AGENTS
See PSYCHOTROPIC DRUGS
PSYCHOTROPIC DRUGS
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PTERIDINES
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PTERINS
See PTERIDINES
PULSARS
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PULSE GENERATORS
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PULSES
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PULVERIZED FUEL ASH
See FLY ASH
PULVERIZED FUELS
Experiments on the combustion of small peat particles in an entrained-flow, isothermal furnace. Research note, 14:46883 (R;FI)
Report on on-line pulverized coal flow meters, 14:47079 (R;FI;In Finnish)
PURIFICATION
Updraft gasification of waste fuels, 14:47020 (R;FI;In Finnish)
PURITY
See IMPURITIES
PWR TYPE REACTORS
Analysis of the VENUS-3 experiments, 14:47105 (R;US)
Assessment of the RETRAN02/MOD3 and RELAP5/MOD2 pressurizer model, 14:47200 (J;US)
Lessons learned from a review of post-accident sampling systems, high range effluent monitors and high concentration particulate iodine samplers, 14:47154 (BA;US)
Matrix database of EPRI experimental projects on small-break loss-of-coolant accidents: Final report, 14:47137 (R;US)
Neutron streaming benchmark calculations, 14:47116 (R;US)
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PYRIDINES
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Radioimmunoassay for pyridostigmine, 14:48085 (R;US)
PYRITE
A comparison between Thiobacillus ferrooxidans and biological by-products in the desulfurization of coal fines in flotation, 14:46812 (RA;US)
Pyrite decomposition and structural alteration of hard coal due to microbe-assisted pyrite removal, 14:46813 (RA;US)
PYRITES
See PYRITE
PYRROLES
Non-aqueous polypyrrole colloids: Synthesis and characterization, 14:47430 (R;US)

Q

QUADRUPOLE MOMENTS
Electric quadrupole moments of the first excited states of $^{130,134,138}Ba$, 14:48451 (R;AU)
QUANTUM CHROMODYNAMICS
General QED/QCD aspects of simple systems, 14:48419 (R;US)
Hidden local symmetries from flavour anomalies of QCD, 14:48398 (RA;PL)
Many-point meson greens functions in the strong-coupling limit of the lattice quantum chromodynamics, 14:48345 (RA;AT;In German)
Surface energy from order parameter profile: At the QCD phase transition, 14:48416 (R;HU)
QUANTUM ELECTRODYNAMICS
Electron-positron system at short distances, 14:48395 (R;XA)
General QED/QCD aspects of simple systems, 14:48419 (R;US)
QUANTUM ELECTRONICS
High power semiconductor laser sources. Final report, 14:47740 (R;US)
QUANTUM FIELD THEORY
Moduli spaces and topological quantum field theories, 14:48418 (R;US)
Nonlocal character of the Rastall model, 14:48420 (J;US)
Stress-tensor commutators and Schwinger terms in singleton theories, 14:48392 (R;XA)
Tachyons in N=2 superconformal models and topological instability of defining the polynomial of Calabi-Yau manifolds, 14:48387 (R;XA)

The classical harmonic oscillator on Galois and P-adic fields, 14:48425 (J;US)

QUANTUM GRAVITY
Charge quantization of wormholes and the finiteness of Newton's constant, 14:48580 (J;NL)
Quantum gravity and cosmological constant, 14:48571 (RA;JP)
SL(2,R) current algebra in two dimensional conformal quantum gravity, 14:48540 (R;XA)

QUANTUM MECHANICS
Continuous spontaneous reduction model involving gravity, 14:48553 (R;XA)
Correlation radius for one-dimensional impenetrable bosons, 14:48554 (R;XA)
Multiconfigurational Green's function approaches in quantum chemistry, 14:47416 (RA;US)
On gauge fixing and quantization of constrained Hamiltonian systems, 14:48557 (R;XA)

QUANTUM NUMBERS
Measurement of Berry's topological phase for non-cyclic evolution, 14:48566 (RA;AT;In German)

QUARK CONFINEMENT
See BAG MODEL

QUARK-GLUON INTERACTIONS
Fluctuations in transverse energy and multiplicity, energy densities, and neutral pion spectra in nucleus-nucleus collissions at 200 GeV/nucleon, 14:48458 (R;US)

QUARK-QUARK INTERACTIONS
Note on the constituent quark cross sections and average charged multiplicities, 14:48339 (RA;PL)

QUARKS
Behaviour of σ_{tot} (e^+e^-->hadrons) in QCD and in theories with scalar quarks, 14:48351 (RA;SU)
Constraints on multiplicity distribution of quark pairs, 14:48341 (RA;PL)
Quark confinement in supersymmetric QCD, 14:48344 (RA;AT;In German)
Spin correlation effects in the hadroproduction and decay of very heavy top quark pairs, 14:48360 (J;US)
Study of muons associated with jets in proton-antiproton collisions at $\sqrt{s}$ = 1.8 TeV, 14:48297 (R;US)

QUARTZ
Characterization of sorbed oil components on clays and quartz grains in oil sand. A contribution to the wettability of reservoir rocks in petroleum deposits, 14:46920 (R;DE;In German)
Explosive volcanism, shock metamorphism and the K-T boundary, 14:48194 (RA;US)
Field-assisted bonding of single crystal quartz, 14:47446 (R;US)
Pneumoconiosis in coal miners and exposure to dust of variable quartz content. Final report, December 1985-May 1988, 14:46887 (R;GB)
Quartz resonator as radiation detector and energy dosimeter, 14:47826 (RA;AT;In German)
Radiation-induced paramagnetic centers in quartz blanks of optical waveguides, 14:48509 (RA;SU;In Russian)

QUEBEC
SOQUIP. Annual report, 1987-1988, 14:47254 (R;CA;In French)

R

R-1650 RESONANCES
See MESONS

RADIATION BELTS
Nonlinear model of wave-particle interactions in the trapped radiation belts: Auroral-pulsation solutions, 14:48235 (R;US)
Space particle environment. Technical report, 14:48237 (R;US)

RADIATION BURDEN
See RADIATION DOSES

RADIATION CHEMISTRY
Radiation chemistry: Little known branch of science, 14:47544 (J;XA)

RADIATION DAMAGE (BIOLOGICAL)
See RADIATION INJURIES

RADIATION DETECTORS
Alpha survey instruments, 14:47153 (BA;US)

RADIATION DOSE DISTRIBUTIONS
Digital two-dimensional scintillation dosimetry, 14:48110 (RA;AT;In German)

RADIATION DOSEMETERS
See DOSEMETERS

RADIATION DOSES
Development of a dose algorithm for the modified panasonic UD-802 personal dosimeter used at three mile island, 14:47176 (J;US)
U.S. NRC emergency response dose assessment model, 14:47156 (BA;US)

RADIATION DOSIMETRY
See DOSIMETRY

RADIATION EXPOSURE (DOSES)
See RADIATION DOSES

RADIATION HYGIENE
See RADIATION PROTECTION

RADIATION INJURIES
Antioxidant mechanisms in radiation injury and radioprotection, 14:48118 (R;US)

RADIATION MONITORS
The role of radiation instruments in the recovery of TMI-2 [Three Mile Island Unit 2], 14:47184 (J;US)

RADIATION PROTECTION
Antioxidant mechanisms in radiation injury and radioprotection, 14:48118 (R;US)
Computer system development to support TMI-2 [Three Mile Island Unit 2] radiological controls, operations, and records management activities, 14:47178 (J;US)
Exposure of the US population from occupational radiation, 14:48130 (R;US)
Financial impact of implementing draft ANSI Standard N13.30, performance criteria for radiobioassay, 14:47148 (R;US)
ORNL (Oak Ridge National Laboratory) implementation of New Health and safety requirements (DOE (Department of Energy) Order 5480.11), 14:46987 (RA;US)
Personnel contamination protection techniques applied during the TMI-2 [Three Mile Island Unit 2] cleanup, 14:47182 (J;US)
Radiation protection survey of research and development activities initiated after the Chernobyl accident. Review report, 14:47143 (R;XN)
Radiation protection training then and now, 14:47181 (J;US)
Room clearance and radiation safety interlock system for neutron therapy treatment room, 14:48111 (R;ZA)
Shippingport: Overall project progress, 14:47002 (R;US)
The significance of radiological control documentation in litigation, 14:47177 (J;US)
Three mile island unit 2 postaccident reactor building entry program, 14:47170 (J;US)
Worker exposures during the TMI-2 [Three Mile Island Unit 2] recovery, 14:47180 (J;US)
[Participation in the Genetic Sub-subgroup at the United Nations Scientific Committee on the Effects of Atomic Radiation]: Foreign trip report, June 13–17, 1988, 14:48131 (R;US)

RADIATION PROTECTION LAWS
Proposed Radiation Control Act: discussion paper, 14:47010 (R;AU)

RADIATION SAFETY
See RADIATION PROTECTION

RADIATION SOURCES
Production of ultra-thin layers of ion-exchange resin and metallic silver by electrospraying, 14:47012 (R;AU)

RADIATION STREAMING
Neutron streaming benchmark calculations, 14:47116 (R;US)

RADIATION TRANSPORT
DABL69: A broad-group neutron/photon cross-section library for defense nuclear applications, 14:48491 (R;US)

RADICALS
Kinetics of the reactions of unsaturated free radicals (methylvinyl and i-C_4H_3) with molecular oxygen, 14:47625 (BA;US)

NH and CH laser-induced fluorescence in low-pressure flames: Quantum yields from time-resolved measurements, 14:47466 (BA;US)
Reactions of hydroxymethyl and hydroxyethyl radicals with molecular and atomic oxygen, 14:47626 (BA;US)
[Free radical and rearrangement reactions in coal liquefaction], 14:46814 (R;US)

RADIOACTIVE BIOLOGICAL WASTES
See RADIOACTIVE WASTES

RADIOACTIVE CLOUDS
Visibility in an atmospheric nuclear dust cloud. Master's thesis, 14:47867 (R;US)

RADIOACTIVE EFFLUENTS
Dispersion of contaminant during oscillatory gas-motions driven by atmospheric pressure variations, 14:47906 (RA;US)
Treatment and disposal options for a heavy metals waste containing soluble Technetium-99, 14:46968 (R;US)

RADIOACTIVE GASEOUS WASTES
See GASEOUS WASTES
RADIOACTIVE WASTES

RADIOACTIVE MATERIALS
Contaminated concrete scabbling at the Shippingport Station Decommissioning Project, 14:47000 (R;US)
Environmental Radiation Data: report 55, July-September 1988. Quarterly report, 14:47966 (R;US)
Technologies and costs for the treatment and disposal of waste byproducts from water treatments for the removal of inorganic and radioactive contaminants (revised draft), September 1986, 14:48040 (R;US)
Ultrapure materials for alpha particle-sensitive applications, 14:47555 (J;US)

RADIOACTIVE PARTICULATES
See PARTICLES

RADIOACTIVE WASTE DISPOSAL
Alternate concentration limits for the UMTRA (Uranium Mill Tailings Remedial Action) Project, 14:46998 (RA;US)
EPA (Environmental Protection Agency) and state authority over DOE (Department of Energy) groundwater radionuclides, 14:46997 (RA;US)
EQ3/6 data base - Ongoing development at Lawrence Livermore National Laboratory, 14:46963 (RA;US)
Geohydrological appraisal of the Vaalputs radioactive waste disposal facility in Namaqualand, South Africa, 14:46977 (R;ZA)
Mineralogical characterization of selected shales in support of nuclear waste repository studies: Progress report, October 1987–September 1988, 14:46974 (R;US)
The Multimedia environmental pollutant assessment system (MEPAS) user-friendly shell, 14:46993 (RA;US)
Training requirements for preparing hazardous waste site workers for involvement with mixed waste, 14:46988 (RA;US)

RADIOACTIVE WASTE FACILITIES
Assessment of potential worker exposure during the operational phase of the Tumulus disposal demonstration project, 14:46950 (RA;US)
Design features of earth mounded concrete bunkers for LLRW (low-level radioactive waste) disposal, 14:46944 (RA;US)
Design of a disposal cell for uranium mill tailings at Collin's Ranch, Oregon: A case study in informal dynamic optimization, 14:46947 (RA;US)
Design, construction, and operations experience with the SWSA 6 (Solid Waste Storage Area 6) tumulus disposal demonstration, 14:46945 (RA;US)
Development of a low-level radioactive waste disposal facility to serve the Central Interstate Compact, 14:46943 (RA;US)
Drumlins - Potential low-level radioactive waste sites, 14:46949 (RA;US)
Eenie, meenie, minie, moe, where do Monument Valley tailings go?, 14:46948 (RA;US)
Engineered surface barriers for waste disposal sites: lysimeter facility design and construction, 14:46946 (RA;US)
Environmental sampling technician training program, 14:46942 (RA;US)
In situ technologies for site remediation, 14:46986 (RA;US)
[US low-level radioactive waste management facility design, construction, and operation]: Foreign trip report, July 22–30, 1989, 14:46973 (R;US)

RADIOACTIVE WASTE MANAGEMENT
Total quality management – Remedial actions planning program, 14:47005 (R;US)

RADIOACTIVE WASTE PROCESSING
Correlation between radwaste processing and hazardous waste treatment processes, 14:46954 (RA;US)
Data acquisition and monitoring of radwaste cementation plants, 14:46964 (R;GB)

RADIOACTIVE WASTES
Characterization of the atmospheric pathway at hazardous waste sites, 14:47921 (RA;US)
Demonstration of new handling equipment configurations for the overpacking of thorium materials, 14:46957 (RA;US)
Fickian filtering of cavity gases rising through a fractured permeable overburden, 14:47905 (RA;US)
Generation of radioactive wastes and the management, 14:46967 (R;JP;In Japanese)
Internal monitoring system for radioactive waste disposal - 1988 conclusions, 14:46956 (RA;US)
Lessons learned from a review of post-accident sampling systems, high range effluent monitors and high concentration particulate iodine samplers, 14:47154 (BA;US)
Mixed waste characterization and certification at the Nevada Test Site, 14:46939 (RA;US)
Ontario Hydro training program for shipping radioactive materials, 14:46934 (RA;US)
The determination of bioaccumulation in edible species from radioactive contamination at the Weldon Spring Site, St. Charles, Missouri, 14:47989 (RA;US)
Total quality management – Remedial actions planning program, 14:47005 (R;US)
Trends in state and local regulations of the transportation of hazardous and radioactive materials, 14:47009 (RA;US)

RADIOAPPLICATORS
See RADIATION SOURCES

RADIOASSAY
Financial impact of implementing draft ANSI Standard N13.30, performance criteria for radiobioassay, 14:47148 (R;US)

RADIOCARBON DATING
See CARBON 14

RADIOECOLOGICAL CONCENTRATION
An approach to remedial action decisions on sites which are marginally contaminated with Radium-226, 14:47004 (R;US)

RADIOFREQUENCY SYSTEMS
See RF SYSTEMS

RADIOISOTOPE MIGRATION
See RADIONUCLIDE MIGRATION

RADIOISOTOPES
Calculated proton-induced thick-target neutron and radionuclide yields for $E_p \leq 100$ MeV, 14:48474 (R;US)
DABL69: A broad-group neutron/photon cross-section library for defense nuclear applications, 14:48491 (R;US)
Estimated low-range costs for the removal of inorganics, radionuclides, and corrosion-related contaminants from potable water supplies (draft), January 1987, 14:48039 (R;US)

RADIOLOGICAL PROTECTION
See RADIATION PROTECTION

RADIOLOGY
PACS image archiving and -communication in radiology, 14:48104 (RA;AT;In German)
PC-supported measuring data recording and flow planning in radiological quality assurance, 14:48106 (RA;AT;In German)
Staircase-shaped test phantom for control of image quality in veterinary medicine, 14:48105 (RA;AT;In German)

RADIOMETERS
[Implementation of radiometry quality-control methods for the Safeguards Analytical Laboratory at Seibersdorf, Austria]: Foreign trip report, October 3–21, 1988, 14:47833 (R;US)

RADIONUCLIDE MIGRATION
Environmental Radiation Data: report 55, July-September 1988. Quarterly report, 14:47966 (R;US)

Geologic containment of radioactive waste, 14:46969 (R;US)
Matrix diffusion user guide (release 2), 14:47987 (R;GB)
Migration of multiradionuclides in sandy soil layer at different acidityes, 14:47993 (R;JP;In Japanese)
Modelling of radioactive fallout in the vicinity of Chernobyl nuclear power plant accident, 14:47126 (R;FR;In French)
[Biospheric Model Validation Study (BIOMOVS) and the revision of IAEA safety series No. 57]: Foreign trip report, November 7–23, 1988, 14:47994 (R;US)
[Training workshop on radiological dose assessment]: Foreign trip report, December 3–8, 1988, 14:48134 (R;US)

RADIONUCLIDE TRANSFER (IN ENVIRONMENT)
See RADIONUCLIDE MIGRATION

RADIONUCLIDES
See RADIOISOTOPES

RADIOPROTECTIVE SUBSTANCES
Thermospray liquid-chromatography mass spectrometry of thiol radioprotective agents: Characteristics spectra. Scientific report, 14:48119 (R;US)

RADIOSURGERY
See RADIOTHERAPY

RADIOTHERAPY
Brachytherapy with I-125: a novel implantation system, 14:48109 (RA;AT;In German)
Digital two-dimensional scintillation dosimetry, 14:48110 (RA;AT;In German)
Irradiation planning by video digitalization, 14:48103 (RA;AT;In German)
Thermospray liquid-chromatography mass spectrometry of thiol radioprotective agents: Characteristics spectra. Scientific report, 14:48119 (R;US)

RADIOWAVE RADIATION
Investigation of r-f emissions from electric-field-dominated plasmas. Final scientific report, 31 January 1980-31 March 1989, 14:48282 (R;US)

RADIUM 215
Properties of $15/2^-$ states in ^{215}Ra and ^{217}Th; evaluation of the $15/2^-$ to $9/2^+$ E3 strength in N=127 isotones, 14:48456 (R;AU)

RADIUM A
See POLONIUM 218

RADIUM E
See BISMUTH 210

RADON
Central radon data base and digitized bedrock map of US EPA (Environmental Protection Agency) Region 1. Technical report, 14:47964 (R;US)
Communicating radon risk effectively: Radon testing in Maryland. Final report, 14:47965 (R;US)
Diagnostic approaches to better solutions of radon IAQ (indoor air quality) problems, 14:47962 (R;US)
Experiment on removal of radon in water by using of de-airing membrane, 14:48048 (RA;JP;In Japanese)
Radon measurements in schools: an interim report, 14:47963 (R;US)
Technologies and costs for the treatment and disposal of waste byproducts from water treatments for the removal of inorganic and radioactive contaminants (revised draft), September 1986, 14:48040 (R;US)

RADON 212
Spectroscopy of ^{212}Rn, 14:48454 (R;AU)

RAIN
Short-term trends and spatial variability in precipitation chemistry in the South Coast Air Basin. Final report, 14:47934 (R;US)

RAINOUT
See WASHOUT

RARE EARTH COMPLEXES
Absorption spectra of rare earth diphthalocyanines in the near IR region, 14:47504 (RA;SU;In Russian)
Spectral characteristics and structure of coordination ethylxanthates of lanthanides, 14:47518 (RA;SU;In Russian)
Spectrochemical study of adducts of rare earth fluorinated β-diketonates, 14:47508 (RA;SU;In Russian)
Use of IR spectroscopy for determination of the structure of mixed-ligand lanthanide complexes with organic phosphorus compounds, 14:47505 (RA;SU;In Russian)

RARE EARTH COMPOUNDS
Correlation study of the structure and spectroscopic characteristics of coordination compounds of double tungstates of alkali and rare earth elements, 14:47520 (RA;SU;In Russian)

RARE GASES
LISA, a time-of-flight spectrometer for measurements of stopping cross sections, 14:47828 (RA;AT;In German)

RAWALPINDI RESEARCH REACTOR
See PARR REACTOR

RC-1 REACTOR
See TRIGA-2-ROME REACTOR

REACTIVITY METERS
Development of on-line reactivity meter for PARR, 14:47112 (R;PK)

REACTOR ACCIDENTS
[Nuclear reactor severe accident chemistry]: Foreign trip report, June 1–9, 1988, 14:47115 (R;US)

Computerized Simulation
Benchmarking of the computer code and the thirty foot side drop analysis for the Shippingport RPV/NST package, 14:47729 (R;US)
Summary of the results of the TMI-2 analysis exercise, 14:47168 (J;US)

Contamination
[Agricultural countermeasures following an accidental release of radionuclides]: Foreign trip report, June 11–22, 1989, 14:48049 (R;US)

Emergency Plans
Programmatic changes due to TMI-2 [Three Mile Island Unit 2]: Accident planning, 14:47187 (J;US)
U.S. NRC emergency response dose assessment model, 14:47156 (BA;US)

Environmental Impacts
Environmental impacts of Chernobyl reactor accident in German Democratic Republic, 14:47130 (R;FR;In French)
Environmental radioactivity and water supply. Pt. 3. The contamination of surface waters in Germany after the Chernobyl reactor accident, 14:47127 (R;FR;In French)
Radiation protection survey of research and development activities initiated after the Chernobyl accident. Review report, 14:47143 (R;XN)
Radiological consequences of the Chernobyl accident in the Soviet union and measures taken to mitigate their impact, 14:47128 (R;FR;In French)
Radiological effects of Chernobyl reactor accident on the lakes of Southern Bavaria, 14:47125 (R;FR;In French)
Radiological impact of the Chernobyl reactor accident, on the countries of the European Community, 14:48124 (RA;FR)
Thyroid dose from ^{131} iodine of the population in Poland following the Chernobyl accident, 14:47129 (R;FR;In French)

Health Hazards
Medical view of the health effects of the pre-Chernobyl nuclear incidents and accidents, 14:48123 (RA;FR)

Legal Aspects
The significance of radiological control documentation in litigation, 14:47177 (J;US)

Local Fallout
Modelling of radioactive fallout in the vicinity of Chernobyl nuclear power plant accident, 14:47126 (R;FR;In French)

M Codes
MARCH calculations performed for the TMI-2 [Three Mile Island Unit] analysis exercise program, 14:47167 (J;US)

Research Programs
Revised Severe Accident Research Program plan, FY 1990–1992, 14:47146 (R;US)

Risk Assessment
Use of probabilistic risk assessment (PRA) in expert systems to advise nuclear plant operators and managers, 14:47157 (BA;US)

Water Pollution
Environmental radioactivity and water supply. Pt. 3. The contamination of surface waters in Germany after the Chernobyl reactor accident, 14:47127 (R;FR;In French)

REACTOR COMPONENTS
Data book of the component failure rate stored in the RECORD, 14:47106 (R;JP;In Japanese)
Design and fabrication Code Case acceptability, ASME Section 3, Division 1, 14:47108 (R;US)
Seismic analysis of a large pool-type LMR [liquid metal reactor], 14:47132 (R;US)
Thermal aging of some decommissioned reactor components and methodology for life prediction, 14:47084 (R;US)
[Reliability of reactor pressure components]: Foreign trip report, October 16–21, 1988, 14:47087 (R;US)

REACTOR COOLING SYSTEMS
A method for suppression of pressure pulses in fluid-filled piping: Theoretical analysis, 14:47099 (R;US)

REACTOR CORE DISRUPTION
Database for the degraded core coolability experiments, 14:48744 (R;JP;In Japanese)

REACTOR CORE RESTRAINTS
Robotic delivery system for plasma cutting of the TMI-2 [Three Mile Island Unit 2] lower core support assembly, 14:47731 (J;US)

REACTOR CORES
Neutronic analysis of a reference LEU core for Pakistan research reactor using oxide fuel, 14:47120 (R;PK)
Performance of the automated cutting equipment system during the plasma cutting of the TMI-2 [Three Mile Island Unit 2] lower core support assembly, 14:47193 (J;US)

REACTOR DISMANTLING
Application of three-dimensional computer solids modeling to TMI-2 [Three Mile Island Unit 2] defueling activities, 14:47197 (J;US)
Criticality analysis support for TMI-2 [Three Mile Island Unit 2] fuel removal operations, 14:47195 (J;US)
Criticality prevention during postaccident decontamination of TMI-2 [Three Mile Island Unit 2] plant systems, 14:47196 (J;US)
Disassembly and defueling of the TMI-2 [Three Mile Island Unit 2] reactor vessel lower core support assembly, 14:47189 (J;US)
Disassembly and defueling of the upper core support assembly, 14:47190 (J;US)
Performance of the automated cutting equipment system during the plasma cutting of the TMI-2 [Three Mile Island Unit 2] lower core support assembly, 14:47193 (J;US)

REACTOR FUEL ELEMENTS
See FUEL ELEMENTS

REACTOR MATERIALS
[Reliability of reactor pressure components]: Foreign trip report, October 16–21, 1988, 14:47087 (R;US)

REACTOR OPERATORS
Radiological conditions and experiences in the TMI-2 [Three Mile Island Unit 2] auxiliary building, 14:47169 (J;US)
The impact of fuel cladding failure events on occupational radiation exposures at nuclear power plants, 14:47155 (BA;US)

REACTOR PHYSICS
Vectorization of nuclear codes 88-1. SRAC, CITATION, TWOTRAN-II, COREBN, CITATION-FBR, 14:47104 (R;JP;In Japanese)

REACTOR SAFETY
Annual report on reactor safety research projects sponsored by the Ministry for Research and Technology of the Federal Republic of Germany 1988, 14:47140 (R;DE)
Basic safety principles for nuclear power plants: INSAG evaluation of the international response, 14:47162 (J;XA)
Reports on research programs in the field of reactor safety sponsored by the Federal Ministry for Research and Technology. Reported period: July 1 - December 31, 1988, 14:47139 (R;DE;In German)

REACTOR VESSELS
[Discussion of fracture mechanics and testing for reactor pressure components, Stuttgart, W. Germany, May 23–27, 1988]: Foreign trip report, 14:47107 (R;US)

REATTORE CASACCIA-1
See TRIGA-2-ROME REACTOR

RECORDS MANAGEMENT
Reporting environmental data of known quality, 14:48742 (R;US)

RECYCLE (FUEL)
See FUEL CYCLE

RECYCLING (FUEL)
See REPROCESSING

REDOX FUEL CELLS
Long-endurance underwater power system. Quarterly report, January-March 1989, 14:47260 (R;US)

REDOX REACTIONS
Fundamental studies in charge separation at interfaces in relation to water photolysis: Progress report, January 15, 1987–June 25, 1989, 14:47483 (R;US)

REDUCING AGENTS
Advanced NO_x reduction processes using -NH and -CN compounds in conjunction with staged air addition, 14:46874 (BA;US)

REDUCTASES
See OXIDOREDUCTASES

REFERENCE MATERIALS (STANDARD)
See CALIBRATION STANDARDS

REFRACTIVITY
Calculation of the refractive index change in dissociating shocked benzene, 14:48524 (R;US)

REFRACTORIES
Nickel oxide, ceramic-insulated, high-temperature coating, 14:47407 (P;US)

REFRIGERATING MACHINERY
Refrigeration for food and people: an essential technology for the welfare of man, 14:47233 (R;US)

REFRIGERATORS
MM & T for linear resonant cooler. Volume 1. Final report, October 1984-September 1986, 14:47712 (R;US)

REFUSE
See SOLID WASTES

REGENERATIVE FUEL CELLS
Cryogenic reactant storage for lunar base regenerative fuel cells, 14:47203 (R;US)

REGION IX
See FEDERAL REGION IX

RELATIVISTIC PLASMA
High-gain plasma Cerenkov Maser, 14:48665 (J;US)

RELAXATION
Solution of the non-linear Boltzmann equation for a homogeneous hard-sphere gas, 14:48263 (RA;AT;In German)

REM
See DOSE EQUIVALENTS

REMEDIAL ACTION
Corrective action investigation of a mixed waste contaminated percolation pond, 14:47003 (R;US)
Data and information management system for the ORNL (Oak Ridge National Laboratory) Remedial Action Program, 14:46999 (RA;US)
Remedial technology screening method, 14:46941 (RA;US)
Supplemental RI/FS (Remedial Investigation/Feasibility Study) guidance for Federal facilities, 14:47217 (RA;US)
The role of risk assessment in remedial action cleanup programs (RACP): A case history, 14:46992 (RA;US)
Use of quantitative risk assessment and risk management in a facility siting issue at Randolph Air Force Base, 14:47984 (RA;US)

REMOTE CONTROL
Land vehicle teleoperation under conditions of reduced video resolution, 14:47724 (R;US)

REMOTE HANDLING
Remote-handled transuranic solid waste characterization study: Oak Ridge National Laboratory, 14:46975 (R;US)

REMOTE HANDLING EQUIPMENT
Development of an underwater remote manipulator system for use in TMI-2 [Three Mile Island Unit 2] reactor defueling, 14:47192 (J;US)

RENEWABLE RESOURCES
Habitat requirements for Chesapeake Bay living resources. Chesapeake Bay Program Agreement Commitment Report, 14:47234 (R;US)
RENORMALIZATION
Absence of wavefunction renormalization in Polyakov amplitudes, 14:48424 (J;NL)
REPROCESSING
Review of some aspects of the solution chemistry of technetium, 14:47481 (R;GB)
RESEARCH PROGRAMS
Technology applications bulletins: Number one, 14:47243 (R;US)
The Government-University-Industry Research Roundtable: 1988 annual report, 14:47241 (R;US)
[Effects of air pollution on forest productivity in Southern Sweden]: Foreign trip report, December 4–9, 1988, 14:47930 (R;US)
RESEARCH REACTORS
Neutronic analysis of a reference LEU core for Pakistan research reactor using oxide fuel, 14:47120 (R;PK)
RESERVOIR FLUIDS
Software for the computation and graphical display of intensive variable phase diagrams, 14:48170 (RA;US)
The effect of pore fluid diffusion in grout spheres, 14:47883 (RA;US)
RESERVOIR ROCK
Characterization of sorbed oil components on clays and quartz grains in oil sand. A contribution to the wettability of reservoir rocks in petroleum deposits, 14:46920 (R;DE;In German)
Density profiles of a draining foam by nuclear magnetic resonance imaging, 14:46897 (J;US)
FY 1988 USGS [US Geological Survey] annual report, 14:46905 (R;US)
MEOR [microbial enhanced oil recovery] data base and evaluation of reservoir characteristics for MEOR projects, 14:46891 (R;US)
Recent material test data and material response models for damage in tuff and grouts, 14:47886 (RA;US)
RESIDENCES
See HOUSES
RESIDENTIAL BUILDINGS
Communicating radon risk effectively: Radon testing in Maryland. Final report, 14:47965 (R;US)
Diagnostic approaches to better solutions of radon IAQ (indoor air quality) problems, 14:47962 (R;US)
Energy consumption of single-family houses. Partly storing electrical heating, 14:47276 (R;FI;In Finnish)
Outdoor air intake in dwellings equipped with mechanical exhaust ventilation, 14:47277 (R;FI;In Finnish)
Performance of ventilation systems in residential buildings, 14:47275 (R;FI;In Finnish)
Reports published by the Gas Research Institute in the area of residential/commercial appliances and space conditioning: bibliography and abstracts. Update through 1988, 14:46917 (R;US)
Residential passive solar research activities related to IEA Task 8: Final report, 14:47265 (R;US)
Topical report on a field-monitoring study of homes with unvented gas space heaters. Volume 4. Quality assurance/control procedures and results. Final report, January 1985-June 1987, 14:47952 (R;US)
RESIDUAL STRESSES
The effect of pore fluid diffusion in grout spheres, 14:47883 (RA;US)
RESIDUES (RADIOACTIVE)
See RADIOACTIVE WASTES
RESINS
Health-hazard evaluation report HETA-87-300-0000, B. F. Goodrich Company, Marietta, Ohio, 14:47944 (R;US)
RESONANCE
Quartz resonator as radiation detector and energy dosimeter, 14:47826 (RA;AT;In German)
RESONANCE CAVITIES
See CAVITY RESONATORS
RESOURCE CONSERVATION
Refrigeration for food and people: an essential technology for the welfare of man, 14:47233 (R;US)
RESOURCE MANAGEMENT
Chesapeake bay basinwide toxics reduction strategy: an agreement commitment report from the Chesapeake Executive Council. Final report, 14:48052 (R;US)
RESOURCE RECOVERY ACTS
Integrated environmental management: A need for change. Technical report, 14:47227 (R;US)
RCRA (Resource Conservation and Recovery Act) inspection manual. Final report, 14:47293 (R;US)
RESPIRABLE DUSTS
See DUSTS
RESPIRATORY SYSTEM
Roles of pH, titratable acid, and specific chemical composition in mediating effects of acid aerosols on the airways. Final report, 14:48147 (R;US)
REVERSE-FIELD PINCH
3-D resistive MHD simulation analysis of field reversal control in the reversed field pinch, 14:48651 (R;JP)
RF SYSTEMS
A proposed linac cavity rf drive system for the Los Alamos extreme ultraviolet free-electron laser, 14:47786 (R;US)
Use of electrostatic probes in R.F. plasmas for materials processing, 14:48622 (RA;AU)
RHENIUM COMPLEXES
NQR and diffuse reflection spectra of rhenium chalcochloride complexes, 14:47510 (RA;SU;In Russian)
Study of rhenium oxohalide coplex interaction with dithiol, 14:47511 (RA;SU;In Russian)
RHENIUM OXIDES
X-ray and γ-ray spectroscopy of solids under pressure: Annual technical progress report, October 1988–October 1989, 14:47471 (R;US)
RHESUS MONKEYS
See MACACUS
RHO-1500 RESONANCES
See MESONS
RHO-1700 RESONANCES
See MESONS
RHODIUM COMPLEXES
Catalogic hydrogenation of carbon monoxide: Final progress report, September 15, 1988–September 14, 1989, 14:47024 (R;US)
Flash photolysis studies of RhCl(CO)L2 (L = trimethyl- or tritolylphosphine). Evidence for intermediates in the photocatalytic carbonylation of hydrocarbons, 14:47541 (J;US)
RHODOSPIRILLUM
Examination of the function of active site lysine 329 of ribulosebisphosphate carboxylase/oxygenase as revealed by the proton exchange reaction, 14:48096 (J;US)
RICHLAND NPR REACTOR
See N-REACTOR
RIEMANN CURVATURE TENSOR
See RIEMANN SPACE
RIEMANN GEOMETRY
See RIEMANN SPACE
RIEMANN MANIFOLDS
See RIEMANN SPACE
RIEMANN METRIC
See RIEMANN SPACE
RIEMANN SPACE
Space of harmonic maps of S^2 into S^4, 14:48561 (R;XA)
RIEMANN SPHERE
See RIEMANN SPACE
RINGOTRON
See ELECTRON-RING ACCELERATORS
RINGS (STORAGE)
See STORAGE RINGS
RISER CRACKING
See COAL LIQUEFACTION
RISK ANALYSIS
See RISK ASSESSMENT

RISK ASSESSMENT
Analysis and management of risks from the nuclear fuel cycle. Final report of the co-ordinated research programme on development of risk criteria for the nuclear fuel cycle, 14:47083 (R;XA)
Approaches to risk training: An evaluation of EPA (Environmental Protection Agency) risk training materials. Technical report, 14:47229 (R;US)
Risk-assessment management, communication: a guide to selected sources. Volume 2, Number 2. Information guide, 14:47230 (R;US)
The Multimedia environmental pollutant assessment system (MEPAS) user-friendly shell, 14:46993 (RA;US)

RIVERS
Charles River lower basin artificial destratification project. Final report, 14:48033 (R;US)

ROAD TRANSPORT
HRIS (Highway Research Information Service) Abstracts. Volume 21, Number 1 - Spring 1988, 14:47278 (R;US)

ROBOTS
Concurrent algorithms for a mobile robot vision system, 14:47770 (BA;US)
Operations and achievements of remote equipment at TMI-2 [Three Mile Island Unit 2], 14:47191 (J;US)
Rethinking synthesis of fine-motion strategies, 14:47723 (R;US)
Robotic delivery system for plasma cutting of the TMI-2 [Three Mile Island Unit 2] lower core support assembly, 14:47731 (J;US)
Summary, retrospect, and evolution of mobile remote systems, 14:47194 (J;US)

ROCK SALT
See SALT DEPOSITS

ROCK-FLUID INTERACTIONS
A theoretical basis for the coupling of chemical reactions to open system processes, 14:48166 (RA;US)
Chlorite solubility between 200°C and 350°C: An experimental and theoretical modeling study, 14:47066 (RA;US)
Improvements in the solid solution modeling capabilities of EQ3/6, 14:48168 (RA;US)
Modelling interaction of deep groundwaters with bentonite, 14:46961 (RA;US)
Predicting mineral dissolution and precipitation during burial: Synthetic diagenetic sequences, 14:47065 (RA;US)
Serpentinization reaction pathways: Implications for modeling approach, 14:47063 (RA;US)

ROCKS
Effective stress model for partially and fully saturated rocks, 14:48161 (R;US)

ROCKY FLATS PLANT
Selection and design of remedial action for the high priority sites at the Rocky Flats Plant, 14:46991 (RA;US)

ROENTGEN EQUIVALENT MAN
See DOSE EQUIVALENTS

ROOFS
Model for roof thermal performance, 14:47270 (R;US)
[Briefings on low slope roof system meetings]: Foreign trip report, June 4, 1989–June 15, 1989, 14:47271 (R;US)

ROTAMAK DEVICES
Current drive and confinement in ANSTO large glass vessel, 14:48595 (RA;AU)
New large rotamak experiment at Flinders university, 14:48607 (RA;AU)
Rotamak research 1987/88, 14:48594 (RA;AU)
Studies of near-spherical plasma discharges in an inexpensive rotamak, 14:48620 (RA;AU)

RURAL AREAS
[Energy projects in the Dominican Republic]: Foreign trip report, May 14–26, 1989, 14:47036 (R;US)

RUTHENIUM COMPLEXES
Application of moessbauer (^{119}Sn) and optical spectroscopy to study bimetallic platinum metal complexes with tin, 14:47514 (RA;SU;In Russian)
ESR study of platinum metal complexing in alkaline medium, 14:47499 (RA;SU;In Russian)
ESR study of products of ruthenium sulfate interaction with 5-amino-1,2,4-dithiazole-3-thione in sulfuric acid solutions, 14:47492 (RA;SU;In Russian)
Fundamental studies in charge separation at interfaces in relation to water photolysis: Progress report, January 15, 1987–June 25, 1989, 14:47483 (R;US)
Peculiarities of electron distribution during sequential reduction of complex ruthenium sulfates, 14:47516 (RA;SU;In Russian)

S

S CODES
Experimental and calculational study of wave/fault interaction, 14:47872 (RA;US)
Model for roof thermal performance, 14:47270 (R;US)
Vectorization of nuclear codes 88-1. SRAC, CITATION, TWOTRAN-II, COREBN, CITATION-FBR, 14:47104 (R;JP;In Japanese)

S MATRIX
Relativistic corrections for the scattering matrix, 14:48565 (RA;AT;In German)

S-1000 RESONANCES
See MESONS

SAFETY
Nuclear power plants: Using PSA to enhance operational safety, 14:47161 (J;XA)

SAFETY (NUCLEAR)
See RADIATION PROTECTION

SAFETY (REACTOR)
See REACTOR SAFETY

SALINE ZONE
See OIL SHALES

SALT DEPOSITS
Computed and measured responses of a thick-walled hollow cylinder of salt subjected to both homogeneous and inhomogeneous loading, 14:46983 (R;US)

SAMARIUM SELENIDES
X-ray and γ-ray spectroscopy of solids under pressure: Annual technical progress report, October 1988–October 1989, 14:47471 (R;US)

SAMARIUM SULFIDES
X-ray and γ-ray spectroscopy of solids under pressure: Annual technical progress report, October 1988–October 1989, 14:47471 (R;US)

SAMPLERS
Generalized ground-water sampling device matrix (journal version), 14:48032 (R;US)

SAMPLING
Environmental sampling technician training program, 14:46942 (RA;US)

SAND
Separation of depleted uranium fragments from gun test catchments: Phase 1, Catchment system evaluation and separations methods, 14:46976 (R;US)

SANDSTONES
FY 1988 USGS [US Geological Survey] annual report, 14:46905 (R;US)
Fracture characteristics and reservoir behavior of stress-sensitive fracture systems in flat-lying lenticular formations, 14:46896 (J;US)
Predicting mineral dissolution and precipitation during burial: Synthetic diagenetic sequences, 14:47065 (RA;US)

SANITARY LANDFILLS
Hydrologic evaluation of seven proposed cap designs, 14:46951 (RA;US)
Ox Mountain sanitary landfill: Apanolio Canyon expansion site, San Mateo County, California. Volume 2. Appendix. Final report, 14:47977 (R;US)
Superfund Record of Decision (EPA Region 1): Landfill and Resource Recovery, Rhode Island (first remedial action), September 1988. Final report, 14:48007 (R;US)

Superfund Record of Decision (EPA Region 1): Old Springfield Landfill, Vermont (first remedial action), September 1988, 14:48080 (R;US)
Superfund Record of Decision (EPA Region 9): Operating Industries, Inc. (OII), Monterey Park, California (third remedial action), September 1988, 14:48001 (R;US)
The applicability of investigative techniques at an abandoned landfill, 14:47981 (RA;US)

SASKATCHEWAN
Saskatchewan Energy and Mines annual report, 1987-88, 14:47235 (R;CA)

SAVANNAH RIVER PLANT
Impacts from the implementation of a prioritization system for funding inactive waste site remediation activities at the Savannah River Plant, 14:46953 (RA;US)

SCALE MODELS
Development of centrifuge modeling for evaluating the mechanisms of collapse of underground opening, 14:47911 (RA;US)

SCATTERING AMPLITUDES
Logarithmic asymptotics of amplitudes in QCD, 14:48331 (RA;PL)

SCAVENGING (ATMOSPHERIC)
See WASHOUT

SCHOOL BUILDINGS
Radon measurements in schools: an interim report, 14:47963 (R;US)

SCHOOL FACILITIES
See EDUCATIONAL FACILITIES

SCHOOL PLANT
See EDUCATIONAL FACILITIES

SCHOOLS
See EDUCATIONAL FACILITIES

SCHROEDINGER EQUATION
Relativistic corrections for the scattering matrix, 14:48565 (RA;AT;In German)

SCLERA
See EYES

SCOTLAND
See UNITED KINGDOM

SCREW INSTABILITY
See HELICAL INSTABILITY

SEALS
Advanced helium purge seals for Liquid Oxygen (LOX) turbopumps. Final report, September 1985-August 1987, 14:47720 (R;US)
Metal and elastomer seal tests for accelerator applications, 14:47804 (R;US)

SEAWATER
[Collection of North Pacific Ocean surface seawater samples for chemical analysis]: Foreign trip report, January 26–February 27, 1988, 14:48022 (R;US)

SEBACEOUS GLANDS
See SKIN

SECONDARY BATTERIES
See ELECTRIC BATTERIES

SECONDARY EMISSION
Fluctuation analysis of relativistic nucleus-nucleus collisions in emulsion chambers, 14:47831 (RA;US)

SECONDARY RECOVERY
See ENHANCED RECOVERY

SEDIMENTS
Causes for geographical variations in OS187/OS186 at the Cretaceous-Tertiary boundary, 14:48210 (RA;US)
Corrective action investigation of a mixed waste contaminated percolation pond, 14:47003 (R;US)
Evaluation of high-resolution gas for the determination of 2, 3, 7, 8-TCDD in soil, sediment and water (journal version), 14:47479 (R;US)
Radio-, Lyo- and Triboluminesence in $CaCO_3$ and NaCl, 14:47474 (RA;AT;In German)
Variant of the thermoluminescence method for sediment age estimation, 14:47473 (RA;AT;In German)

SEISMIC EVENTS
Earthquake recurrence rate estimates for eastern Washington and the Hanford Site, 14:48162 (R;US)

SEISMIC P WAVES
Possible relation between sonic velocity measured at the edge of a large borehole and shear failure, 14:47895 (RA;US)

SELENIUM
Cost supplement to technologies and costs for the removal of selenium from potable-water supplies (first draft), February 1987. Draft report, 14:48043 (R;US)
Drinking-Water Criteria Document for selenium (final draft), December 1986, 14:48068 (R;US)

SEMICONDUCTOR COUNTERS
See SEMICONDUCTOR DETECTORS

SEMICONDUCTOR DETECTORS
Mechanisms leading to single event upset, 14:47821 (R;US)

SEMICONDUCTOR DEVICES
Heavy ion induced single event phenomena (SEP) data for semiconductor devices from engineering testing, 14:47437 (R;US)

SEMICONDUCTOR DIODES
Spatial and frequency dependence of four-wave mixing in broad-area diode lasers, 14:47737 (R;US)

SEMICONDUCTOR LASERS
High power semiconductor laser sources. Final report, 14:47740 (R;US)
Spatial and frequency dependence of four-wave mixing in broad-area diode lasers, 14:47737 (R;US)
Transverse pumping with diode lasers. Technical report, 14:47739 (R;US)

SEMICONDUCTOR MATERIALS
Improved Kohn-Sham exchange potential, 14:47344 (RA;US)
Pseudopotential calculations of structural properties of solids, 14:48526 (BA;US)
Structural aspects of band offsets at heterojunction interfaces, 14:47340 (RA;US)

SEMICONDUCTOR SWITCHES
Subnanosecond linear GaAs photoconductive switching: Revision 1, 14:47727 (R;US)

SERPENTINITES
Serpentinization reaction pathways: Implications for modeling approach, 14:47063 (RA;US)

SEWAGE
Needs survey report to Congress, 1988: assessment of needed publicly owned waste-water treatment facilities in the United States, 14:48058 (R;US)
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Wetlands and waste-water management: Questions, answers, advice, and guidance. Technical report, 14:48063 (R;US)

SEWAGE SLUDGE
Baghouse efficiency on a multiple-hearth incinerator burning sewage sludge, 14:47950 (R;US)
Sewage-treatment costs and economics. July 1987-July 1989 (Citations from the NTIS data base). Report for July 1988-July 1989, 14:47300 (R;US)
Sludge Incineration Model (SIM) (for microcomputers). Model-Simulation, 14:47298 (R;US)
Sludge Incineration Modeling (SIM) system user's guide. Draft report, 14:48051 (R;US)
Use of surface peat in growing media for landscaping and public gardens in Northern Finland, 14:47039 (R;FI;In Finnish)

SHALE OIL
Parachute Creek Shale Oil Program. Environmental monitoring plan, Annual report, October 1, 1987-September 30, 1988, 14:46924 (R;US)

SHALES
Mineralogical characterization of selected shales in support of nuclear waste repository studies: Progress report, October 1987–September 1988, 14:46974 (R;US)

SHEILA HELIAC
ECRH experiments on the SHEILA heliac, 14:48593 (RA;AU)
ECRH experiments using a 2.45GHz domestic microwave oven magnetron, 14:48612 (RA;AU)

SHELLS
Fission-fusion adaptivity in finite elements for nonlinear dynamics of shells. Annual technical report, 1 October 1987-30 September 1988, 14:48461 (R;US)
SHF RADIATION
See RADIOWAVE RADIATION
SHIELDING MATERIALS
Decontamination and coating of lead, 14:46955 (RA;US)
SHIP PROPULSION REACTORS
Concept design of Advanced Marine Reactor (1), core design. Design study for optimized core, 14:47102 (R;JP;In Japanese)
SHIPMENT
See TRANSPORT
SHIPPINGPORT PRESSURIZED WATER REACTOR
See SHIPPINGPORT REACTOR
SHIPPINGPORT REACTOR
Benchmarking of the computer code and the thirty foot side drop analysis for the Shippingport RPV/NST package, 14:47729 (R;US)
Contaminated concrete scabbling at the Shippingport Station Decommissioning Project, 14:47000 (R;US)
Marine transportation and burial of the Shippingport Reactor Pressure Vessel/Neutron Shield Tank (RPV/NST) package, 14:47001 (R;US)
Preparation, lifting and loading of the Shippingport Reactor Pressure Vessel/Neutron Shield Tank Package, 14:47134 (R;US)
Shippingport: Overall project progress, 14:47002 (R;US)
SHIPS
Model experiments of ship fire, 14:47652 (BA;US)
SHOCK (IMPACT)
See IMPACT SHOCK
SHOWER COUNTERS
[Data acquisition of WA80 calorimeters with ^{32}S beams]: Foreign trip report, September 11, 1987–October 13, 1987, 14:47834 (R;US)
[WA80 collaboration, Muenster, W. Germany, April 17–21, 1989]: Foreign trip report, 14:47836 (R;US)
SIALON
See ALUMINIUM OXIDES
SILICON NITRIDES
SID
See SUDDEN IONOSPHERIC DISTURBANCE
SIGMA MODEL
Sigma models and renormalization of string loops, 14:48388 (R;XA)
SIGMA-410 RESONANCES
See SIGMA MODEL
SIGNAL CONDITIONING
Comparison of superconductive and surface-acoustic-wave signal processing, 14:47763 (R;US)
SILICA
Characterization of surface properties affecting the activity of the 'free silica' fraction of respirable dusts. Final report, 14:47943 (R;US)
Partial oxidation reactions of methane and oxygen, 14:47018 (R;US)
Post-failure strength of gypsum silica-sand aggregate stemming material, 14:47885 (RA;US)
Static tensile and tensile creep testing of five ceramic fibers at elevated temperatures, 14:47397 (R;US)
Surface structure of silica glasses by molecular dynamics simulations, 14:47453 (BA;US)
SILICEOUS ROCK
See SANDSTONES
SILICON
Defects in H^+- and He^+-irradiated silicon, 14:47429 (RA;AT;In German)
EBIC evidence for carbon-based gettering in EFG silicon, 14:47456 (BA;US)
Effect of pressure on self diffusion in crystalline silicon, 14:47458 (BA;US)
Electrical, optical and structural properties of thin SiO_2 films on Si, 14:47406 (BA;US)
Electronic properties of liquid silicon, 14:47452 (BA;US)
Hydrogen-assisted thermal donor formation in silicon, 14:48522 (R;US)
Investigation of impurity neutralization and defect passivation in polycrystalline silicon solar cells, 14:47454 (BA;US)
Ion beam processes in advanced electronic materials and device technology, 14:47449 (B;US)
Monte Carlo simulation of growth of crystalline and amorphous silicon, 14:47455 (BA;US)
Oxygen, carbon, hydrogen and nitrogen in crystalline silicon, 14:47450 (B;US)
Pseudopotential calculations of structural properties of solids, 14:48526 (BA;US)
Recombination centres in electron- and neutron irradiated Si diodes, 14:47840 (RA;AT;In German)
Theoretical considerations regarding impurities in silicon and the chemisorption of simple molecules on nickel, 14:47343 (RA;US)
Transient enhanced diffusion and gettering of dopants in ion implanted silicon, 14:47457 (BA;US)
Transmutation process simulation in silicon during mean energy proton irradiation, 14:48513 (RA;SU;In Russian)
Vibrational properties of the π-bonded chain model of the Si(111) 2 x 1 surface, 14:48279 (BA;US)
Wavefunctions and charge densities for defects in solids: A success for semiempirical theory, 14:47341 (RA;US)
SILICON CARBIDES
Effect of thermal and cyclic loads on silicon carbide yarn reinforced glass matrix composites: Final report, August 15, 1984–February 14, 1988, 14:47419 (R;US)
SiC-based thin-filament pyrometry: Theory and thermal properties, 14:47702 (BA;US)
Static tensile and tensile creep testing of five ceramic fibers at elevated temperatures, 14:47397 (R;US)
SILICON IONS
Charge state dependence of K X-ray production in thin targets by multicharged silicon ions, 14:48281 (J;NL)
SILICON NITRIDES
Improved silicon nitride for advanced heat engines. Annual contractor report, 14:47395 (R;US)
Low temperature processing of reaction sintered silicon nitride, 14:47401 (R;US)
SILICON OXIDES
Electrical, optical and structural properties of thin SiO_2 films on Si, 14:47406 (BA;US)
SILICON SOLAR CELLS
EBIC evidence for carbon-based gettering in EFG silicon, 14:47456 (BA;US)
Investigation of impurity neutralization and defect passivation in polycrystalline silicon solar cells, 14:47454 (BA;US)
Preparation and properties of high deposition a-Si:H films and solar cells using disilane: Final subcontract report, 1 May 1988–30 April 1989, 14:47041 (R;US)
SILICOSIS
See PNEUMOCONIOSES
SILVER 107 TARGET
Results from WA80 on transverse energy production, fluctuations in multiparticle production, and γ/π^0 ratios, 14:48444 (J;NL)
SILVER IODIDES
^{127}I NQR study of holmium iodide compounds with monovalent metals (Metals: K, Rb, Cs, Ag, Tl.), 14:47515 (RA;SU;In Russian)
SINGLE CRYSTALS
See MONOCRYSTALS
SKIN
[Low dose radiation biological bases of risk assessment]: Foreign trip report, September 2-21, 1988, 14:48133 (R;US)
SKYRMIONS
See SOLITONS
SLUDGES
Composting of surface peat, waste water sludge and bark, the properties and suitability of substietes for growing media for landscaping, 14:47038 (R;FI;In Finnish)
Superfund Record of Decision: (EPR Region 6): Curley Pit Site, ground-water operable unit, Crittenden County, Arkansas

(second remedial action), September 1988. Final report, 14:48055 (R;US)
Treatment and disposal options for a heavy metals waste containing soluble Technetium-99, 14:46968 (R;US)

SLURRIES (FUEL)
See FUEL SLURRIES

SMELTERS
Smelting networks for real time cooperative planning in the presence of uncertainties, 14:47295 (BA;US)

SMELTING
Air quality studies in the western United States, 14:47925 (R;US)

SMOKATRON
See ELECTRON-RING ACCELERATORS

SMOKES
Correlations for smoke points and radiant emission of laminar hydrocarbon diffusion flames, 14:47567 (BA;US)

SODIUM
Determination of relative number density and decay rate for atomic sodium in an atmospheric premixed flame by Asynchronous Optical Sampling, 14:47468 (BA;US)
Electron scattering from sodium at intermediate energies, 14:48247 (R;AU)
Investigations of vapour explosions with alumina-droplets in sodium, 14:47145 (R;DE;In German)
Metals in intimate contact, 14:47336 (RA;US)
Promotion of char oxidation by inorganic constituents, 14:46849 (BA;US)
Solar-powered alkali metal vapor lasers. Final report, 1 August 1986-31 October 1988, 14:47747 (R;US)

SODIUM 22
Yrast 8^+ and 9^+ states of ^{22}Na, 14:48443 (R;AU)

SODIUM CHLORIDES
Radio-, Lyo- and Triboluminesence in $CaCO_3$ and NaCl, 14:47474 (RA;AT;In German)

SODIUM IODIDE DETECTORS
See NAI DETECTORS

SODIUM MINERALS
See MINERALS

SODIUM OXIDES
Phase I, Volume I, Program summary and PDU [process development unit] operations: Topical report, October 1987–January 1989, 14:46816 (R;US)

SODIUM-SULFUR BATTERIES
Sodium/sulfur battery studies at SNL [Sandia National Laboratories], 14:47207 (R;US)

SODIUM-WATER REACTIONS
See MOLTEN METAL-WATER REACTIONS

SOILING
See SURFACE CONTAMINATION

SOILS
An approach to remedial action decisions on sites which are marginally contaminated with Radium-226, 14:47004 (R;US)
Environmental studies in support of the live fire training facilities project, 14:48028 (R;US)
Error introduced into a water density measurement due to the presence of a water density gradient, 14:47971 (R;AU)
Evaluation of high-resolution gas for the determination of 2, 3, 7, 8-TCDD in soil, sediment and water (journal version), 14:47479 (R;US)
Migration of multiradionuclides in sandy soil layer at different acidityes, 14:47993 (R;JP;In Japanese)
Preliminary assessment/site investigation: Tooele Army Depot, Utah. Volume 2. South Area. Final report, 14:48017 (R;US)
Spectral reflectance characteristics of clay-bearing soils: Applications to downhole environments, 14:47898 (RA;US)

SOLAR ACTIVITY
NASA Marshall Space Flight Center solar observatory report, January-December 1987, 14:48217 (R;US)
Solar-Geophysical Data Number 534, February 1989. Part 1 (prompt reports). Data for January 1989, December 1988, and late data, 14:48219 (R;US)
Solar-Geophysical Data Number 535, March 1989. Part 1 (prompt reports). Data for February, January 1989, and late data, 14:48221 (R;US)
Solar-Geophysical Data Number 535, March 1989. Part 2 (comprehensive reports). Data for September 1988, and miscellaneous, 14:48222 (R;US)

SOLAR BATTERIES
See SOLAR CELL ARRAYS

SOLAR CELL ARRAYS
Evaluation of atomic oxygen resistant protective coatings for fiberglass-epoxy composites in LED, 14:47033 (R;US)
Restrictive loads powered by separate or by common electrical sources, 14:47044 (R;US)

SOLAR COLLECTORS
Attractive economy and durability of building integrated solar collector systems, 14:47049 (RA;DK)
High-temperature solar electrothermal processing. Final report, July 1982-March 1989, 14:47046 (R;US)

SOLAR CORONA
Equilibrium of solar coronal arcades. Interim report, 14:48175 (R;US)

SOLAR ENERGY
Design and construction of thermal solar equipments: flat plate solar collectors, 14:47048 (R;FR;In French)

SOLAR ENERGY CONVERSION
High-temperature solar electrothermal processing. Final report, July 1982-March 1989, 14:47046 (R;US)

SOLAR FLARES
Solar-Geophysical Data Number 534, February 1989. Part 1 (prompt reports). Data for January 1989, December 1988, and late data, 14:48219 (R;US)
Solar-Geophysical Data Number 535, March 1989. Part 1 (prompt reports). Data for February, January 1989, and late data, 14:48221 (R;US)
Solar-Geophysical Data Number 535, March 1989. Part 2 (comprehensive reports). Data for September 1988, and miscellaneous, 14:48222 (R;US)

SOLAR FURNACES
High-temperature solar electrothermal processing. Final report, July 1982-March 1989, 14:47046 (R;US)

SOLAR HEATING
High-temperature solar electrothermal processing. Final report, July 1982-March 1989, 14:47046 (R;US)
Investigation of needs for active solar design tools: [Final report], October 1, 1985–February 1, 1986, 14:47047 (R;US)

SOLAR HEATING SYSTEMS
Investigation of needs for active solar design tools: [Final report], October 1, 1985–February 1, 1986, 14:47047 (R;US)

SOLAR MODELS
See STAR MODELS

SOLAR NEUTRINOS
The Baksan gallium solar neutrino experiment, 14:48318 (R;US)

SOLAR PONDS
Design of direct-contact preheater/boilers for solar pond power plants, 14:47045 (BA;US)

SOLAR PROCESS HEAT
High-temperature solar electrothermal processing. Final report, July 1982-March 1989, 14:47046 (R;US)

SOLAR PROMINENCES
Solar-Geophysical Data Number 535, March 1989. Part 2 (comprehensive reports). Data for September 1988, and miscellaneous, 14:48222 (R;US)

SOLAR RADIATION
Distribution and seasonal variations of diffuse fraction, 14:47918 (R;XA)
NASA Marshall Space Flight Center solar observatory report, January-December 1987, 14:48217 (R;US)
Solar-Geophysical Data Number 534, February 1989. Part 1 (prompt reports). Data for January 1989, December 1988, and late data, 14:48219 (R;US)
Solar-Geophysical Data Number 535, March 1989. Part 1 (prompt reports). Data for February, January 1989, and late data, 14:48221 (R;US)
Solar-Geophysical Data Number 535, March 1989. Part 2 (comprehensive reports). Data for September 1988, and miscellaneous, 14:48222 (R;US)

SOLAR RADIO BURSTS
Solar-Geophysical Data Number 535, March 1989. Part 2 (comprehensive reports). Data for September 1988, and miscellaneous, 14:48222 (R;US)
SOLAR THERMAL POWER PLANTS
Design of direct-contact preheater/boilers for solar pond power plants, 14:47045 (BA;US)
SOLAR WIND
Hybrid simulations of a curved shock, 14:48184 (R;US)
Solar-Geophysical Data Number 535, March 1989. Part 2 (comprehensive reports). Data for September 1988, and miscellaneous, 14:48222 (R;US)
Wave sources of momentum and heat in solar wind, 14:48181 (RA;SU;In Russian)
SOLID FUELS
Driving of axial acoustic waves by side-wall stabilized premixed flames, 14:47658 (BA;US)
Model of the flow assisted spread of flames over a thin charring combustible, 14:47643 (BA;US)
Near-limit flame spread over a thin solid fuel in microgravity, 14:47644 (BA;US)
SOLID STATE LASERS
Nonradiative relaxation and laser action in tunable solid state laser crystals. Final technical report, 1 September 1987-31 December 1988, 14:47745 (R;US)
Ti-sapphire laser performance above 15 watts cw with line-narrowing, 14:47748 (R;US)
SOLID WASTES
Anaerobic digestion: Annual report, FY 1988, 14:47027 (R;US)
Baghouse efficiency on a multiple-hearth incinerator burning sewage sludge, 14:47950 (R;US)
EPA's (Environmental Protection Agency) role in non-hazardous solid-waste management on Indian land: Issues and options. Technical report, 14:47231 (R;US)
Remote-handled transuranic solid waste characterization study: Oak Ridge National Laboratory, 14:46975 (R;US)
Study and assessment of eight yard waste-composting programs across the United States. Technical report, 14:47299 (R;US)
[Land disposal of solid waste]: Foreign trip report, March 13–21, 1988, 14:47297 (R;US)
SOLIDS
Pseudopotential calculations of structural properties of solids, 14:48526 (BA;US)
Stopping cross section for fast ions, 14:48265 (RA;AT;In German)
SOLITONS
New class of non-topological solitons, 14:48417 (R;US)
SOLVENTS
Critique of several regulatory analyses regarding solvent wastes. Technical report, 14:48000 (R;US)
Donor hydrogen depletion in coal liquefaction, 14:46793 (R;US)
SOMATIC CELLS
Multiple endpoints for somatic mutations in humans provide complementary views for biodosimetry, genotoxicity, and health risks, 14:48094 (R;US)
SONDES
See PROBES
SOOT
A picture of soot particle inception, 14:47564 (BA;US)
An investigation of soot formation in axisymmetric turbulent diffusion flames at elevated pressure, 14:47574 (BA;US)
Combustion efficiency, radiation, CO and soot yield from a variety of gaseous, liquid, and solid fueled buoyant diffusion flames, 14:46902 (BA;US)
Correlations for smoke points and radiant emission of laminar hydrocarbon diffusion flames, 14:47567 (BA;US)
Effects of turbulence on flame radiation from diffusion flames, 14:47648 (BA;US)
Experimental and computational investigation of the structure of a sooting C_2H_2-O_2-Ar flame, 14:47562 (BA;US)
Experiments on the sooting limits of aerodynamically-strained diffusion flames, 14:47570 (BA;US)
Flowfield modeling of soot formation at elevated pressure, 14:47573 (BA;US)
Preferential diffusion and concentration modification in sooting counterflow diffusion flames, 14:47569 (BA;US)
Radiative properties of chain-agglomerated soot formed in hydrocarbon diffusion flames, 14:47647 (BA;US)
Some new observations concerning the mass growth of soot in premixed hydrocarbon-oxygen flames, 14:47565 (BA;US)
Soot aerosol dynamics in a laminar ethylene diffusion flame, 14:47566 (BA;US)
Soot formation in combustion processes, 14:47561 (BA;US)
Soot formation in diffusion flames of fuel/oxygen mixtures, 14:47568 (BA;US)
The behavior of polycyclic aromatic hydrocarbons during the early stages of soot formation, 14:47563 (BA;US)
The influence of pressure and temperature on soot formation in premixed flames, 14:47572 (BA;US)
The roles of innate oxygen and adsorbed oxygen in the chemistry of soot oxidation by oxygen atoms at 298 K, 14:47575 (BA;US)
SOURCE TERMS
Environmental measurements during the TMI-2 [Three Mile Island Unit 2] accident, 14:47171 (J;US)
TMI [Three Mile Island] and the environment, 14:47172 (J;US)
SOUTH AFRICA
Sudbury Structure (Ontario, Canada) and Vredefort Structure (South Africa): A comparison, 14:48195 (RA;US)
SOVIET UNION
See USSR
SPACE FLIGHT
[Workshop on radiation research related to space stations and missions beyond the magnetosphere]: Foreign trip report, July 17–24, 1988, 14:48132 (R;US)
SPACE HEATING
Gas Research Institute: an update, January 1989, 14:46909 (R;US)
SPACE LATTICES
See CRYSTAL LATTICES
SPACE REFLECTION
See P INVARIANCE
SPACE VEHICLES
Transatospheric laser propulsion: Final report, 14:47279 (R;US)
SPARK IGNITION ENGINES
A detailed chemical kinetic reaction mechanism for the oxidation of iso-octane and n-heptane over an extended temperature range and its application to analysis of engine knock, 14:47619 (BA;US)
Development of hot nitrogen kernel, produced by a very fast spark discharge, 14:47304 (BA;US)
Experimental simulation of engine knock by means of a preheated static combustion chamber, 14:47301 (BA;US)
Fiber-optic instrumented spark plug for measuring early flame development in spark ignition engines, 14:47310 (B;US)
Mechanism of flame kernel formation produced by short duration sparks, 14:47303 (BA;US)
Prediction of knock occurrence in a spark-ignition engine, 14:47302 (BA;US)
SPARKS (ELECTRIC)
See ELECTRIC SPARKS
SPECIFIC HEAT
Influence of fluctuations on the phase transformations in the superconductor, 14:47358 (RA;AT;In German)
SPECTROSCOPY
[Electron-beam induced spectroscopies at very high spatial resolution]: Foreign trip report, April 26–March 12, 1988, 14:47847 (R;US)
SPENT FUEL CASKS
Evaluation of burnup credit for dry storage casks, 14:46966 (R;US)
SPENT FUEL STORAGE
Evaluation of burnup credit for dry storage casks, 14:46966 (R;US)
SPENT FUELS
Burnup determination by the isotope correlation technique. Summary, 14:47094 (RA;XA)
Evaluation of burnup credit for dry storage casks, 14:46966 (R;US)

Non-destructive burnup determination of spent fuel in the framework of nuclear material safeguards, 14:47007 (RA;XA)
Studies on spent fuel dissolution behavior under Yucca Mountain repository conditions, 14:46980 (R;US)

SPERM
See SPERMATOZOA

SPERMATIDS
See SPERMATOZOA

SPERMATOZOA
RBE [relative biological effectiveness] of tritium beta radiation to gamma radiation and x-rays analyzed by both molecular and genetic methods, 14:48121 (R;US)

SPHERES (FUEL)
See FUEL SPHERES

SPICES
Influence of storage on fungal infestation in spices, 14:48128 (R;PK)

SPICULES
See SOLAR PROMINENCES

SPIN
Spin fluctuations and weak itinerant ferromagnetism in $Y(Co_{1-x}Al_x)_2$ ($0{,}00 \leq x \leq 0{,}18$), 14:47357 (RA;AT;In German)

SPIN ORIENTATION
Measurement of Berry's topological phase for non-cyclic evolution, 14:48566 (RA;AT;In German)

SPIN-OFF
See TECHNOLOGY TRANSFER

SPLINE FUNCTIONS
An interactive program for constrained spline approximation of numerical data, 14:48735 (R;US)

SPRAY COATING
Production of ultra-thin layers of ion-exchange resin and metallic silver by electrospraying, 14:47012 (R;AU)

SPRAY PONDS
See SPRAYS

SPRAYS
Numerical study of multicomponent fuel spray flame propagation in a spherical closed volume, 14:47705 (BA;US)
Unsteady flame propagation in a spray with transient droplet vaporization, 14:47704 (BA;US)

SPUTTERING
Spectroscopic measurements of the energy of sputtered copper atoms, 14:48502 (RA;AU)

SQUID DEVICES
Comparison of superconductive and surface-acoustic-wave signal processing, 14:47763 (R;US)

SRM
See CALIBRATION STANDARDS

STABLE ISOTOPES
Progress in stable isotope analysis and new possibilities of clinical investigations, 14:48100 (R;FR)

STAINLESS STEEL-18-4-1
See STAINLESS STEELS

STAINLESS STEEL-19-9DL
See STAINLESS STEELS

STAINLESS STEEL-Z2CN18-10N
See CHROMIUM-NICKEL STEELS

STAINLESS STEEL-Z3CMN18-8-6N
See CHROMIUM-NICKEL STEELS

STAINLESS STEEL-Z3CND18-13
See CHROMIUM-NICKEL STEELS

STAINLESS STEEL-Z6CND17-13B
See CHROMIUM-NICKEL STEELS

STAINLESS STEEL-Z6CNDT17-13B
See CHROMIUM-NICKEL STEELS

STAINLESS STEEL-Z6CNT18-12B
See CHROMIUM-NICKEL STEELS

STAINLESS STEELS
Polishing methods for metallic and ceramic transmission electron microscopy specimens: Revision 1, 14:47329 (R;US)
Thermal aging of some decommissioned reactor components and methodology for life prediction, 14:47084 (R;US)

STANDARD REFERENCE MATERIALS
See CALIBRATION STANDARDS

STANDING CROP
See BIOMASS

STAR CLUSTERS
Effects of main-sequence mass loss on the turnoff ages of globular clusters, 14:48186 (R;US)
Effects of main-sequence mass loss on the turnoff ages of population 1 clusters, 14:48185 (R;US)

STAR EVOLUTION
Grids of evolutionary models from 0.85 to 120 solar masses: Observational tests and the mass limits, 14:48224 (R;CH)
Tables of evolutionary star models from 0.85 to 120 solar masses with overshooting and mass loss, 14:48225 (R;CH)

STAR MODELS
Grids of evolutionary models from 0.85 to 120 solar masses: Observational tests and the mass limits, 14:48224 (R;CH)
Tables of evolutionary star models from 0.85 to 120 solar masses with overshooting and mass loss, 14:48225 (R;CH)

STARS
Forbidden coronal iron line emission in the Puppis A shock front: The effect of inhomogeneities, 14:48188 (R;US)
Grids of evolutionary models from 0.85 to 120 solar masses: Observational tests and the mass limits, 14:48224 (R;CH)
Properties of strongly coupled multi-ionic plasmas, 14:48228 (R;US)
Tables of evolutionary star models from 0.85 to 120 solar masses with overshooting and mass loss, 14:48225 (R;CH)

STATIONARY POLLUTANT SOURCES
Development of sampling methods for source PM10 emissions. Final report, 14:47951 (R;US)

STATISTICS
Maximum-likelihood identification of structurally constrained covariances for initial-condition statistics, 14:48538 (R;US)

STATORS
High gain flux compression generator fabrication issues, 14:47768 (R;US)

STEADY-STATE FUSION REACTORS
Projections for a steady-state tokamak reactor based on ITER, 14:48693 (R;US)

STEAM
Measurements of nitrogen Q-branch foreign gas-broadening coefficients relevant to flames, 14:47464 (BA;US)
Similarity analysis of condensing flow in a fluid driven fracture, 14:47875 (RA;US)
Steam explosion triggering and propagation: Hypotheses and evidence, 14:47152 (R;US)

STEAM COOLANT
See STEAM

STEAM INJECTION
Steam-zone electrical characteristics for geodiagnostic evaluation of steamflood performance, 14:46895 (BA;US)

STEEL INDUSTRY
See METAL INDUSTRY

STEEL-000KH18N13
See CHROMIUM-NICKEL STEELS

STEEL-000KH20N16AG6
See CHROMIUM-NICKEL STEELS

STEEL-000KH25
See STAINLESS STEELS

STEEL-000KH28
See STAINLESS STEELS

STEEL-00KH20N32T
See STAINLESS STEELS

STEEL-03KH11N10M2TK6
See CHROMIUM-NICKEL STEELS

STEEL-03KH13AG13
See STAINLESS STEELS

STEEL-0KH18G8N2T
See STAINLESS STEELS

STEEL-0KH19NT
See CHROMIUM-NICKEL STEELS

STEEL-12KH2MV8FB
See STEELS

STEEL-12KH2V5FB
See STEELS

STEEL-18KH16N6
See CHROMIUM-NICKEL STEELS
STEEL-1KH12V2MF
See CHROMIUM STEELS
STEEL-1KH16N14V2BR EHP17
See CHROMIUM-NICKEL STEELS
STEEL-1KH16N4B
See CHROMIUM-NICKEL STEELS
STEEL-20KH2N2M
See CHROMIUM-NICKEL STEELS
STEEL-20KHN3MF
See CHROMIUM-NICKEL STEELS
STEEL-2KH18N8V2
See CHROMIUM-NICKEL STEELS
STEEL-3KH15N13YU3
See CHROMIUM-NICKEL STEELS
STEEL-4KH12N8G8MFB
See CHROMIUM-NICKEL STEELS
STEEL-4KH14NV2M
See CHROMIUM-NICKEL STEELS
STEEL-9KHS
See CHROMIUM STEELS
STEEL-DIN-1-4449
See CHROMIUM-NICKEL STEELS
STEEL-KH13S2YU2BT
See CHROMIUM STEELS
STEEL-KH14N8YUM2
See CHROMIUM-NICKEL STEELS
STEEL-KH18N8
See CHROMIUM-NICKEL STEELS
STEEL-KN15N7YUM2
See CHROMIUM-NICKEL STEELS
STEEL-KN15N9YU
See CHROMIUM-NICKEL STEELS
STEEL-R18
See CHROMIUM STEELS
STEELS
Polyelectrolyte-diffused zinc phosphate conversion coatings and polyacid coupling primers for corrosion protection of steel and aluminum, and alkali-catalyzed hydrolysis of polyimide-based materials: Final report, 14:47414 (R;US)
The Meta-Lax method of stress reduction in welds: First quarterly report, 14:47349 (R;US)
STELLAR ATMOSPHERES
Application of the generalized newton-raphson method to the singly-ionized calcium line formation problem in model stellar atmospheres. Doctoral thesis, 14:48220 (R;US)
STELLAR RADIATION
Energy in physics, war and peace, 14:47016 (B;US)
STELLARATORS
Great stellarator revival, 14:48681 (RA;AU)
On bootstrap currents in toroidal systems, 14:48644 (R;DE)
STEMMING MATERIALS
Post-failure strength of gypsum silica-sand aggregate stemming material, 14:47885 (RA;US)
Recent material test data and material response models for damage in tuff and grouts, 14:47886 (RA;US)
Stemming column phenomenology, 14:47884 (RA;US)
STEROIDS
Kinetics and quantitative analysis of the isomerization and aromatization of fossil steroid hydrocarbons within experiments and in naturally matured sample sequences, 14:46889 (R;DE;In German)
STIMULATED EMISSION
Demonstration of the feasibility of the tuning and stimulation of nuclear radiation. Final report, 1 July 1981-31 October 1988, 14:48445 (R;US)
STIRLING CYCLE
Environmental test report on the CTI-Cryogenics 1-watt integral Stirling cooler (long-life HD-1033d). Final report, 16 June-24 July 1988, 14:47715 (R;US)
MM & T for linear resonant cooler. Volume 1. Final report, October 1984-September 1986, 14:47712 (R;US)
STOPPING
See ABSORPTION
STOPPING POWER
Electronic stopping power of ions in solids, 14:48529 (J;NL)
STOPPING POWER (TOTAL ATOMIC)
See STOPPING POWER
STOPPING POWER (TOTAL LINEAR)
See STOPPING POWER
STOPPING POWER (TOTAL MASS)
See STOPPING POWER
STORAGE (SPENT FUEL)
See SPENT FUEL STORAGE
STORAGE BATTERIES
See ELECTRIC BATTERIES
STORAGE FACILITIES
Management program for underground storage tanks at the Idaho National Engineering Laboratory, 14:47779 (RA;US)
STORAGE RINGS
[Design of synchrotron/cooler/storage rings]: Foreign trip report, June 4, 1988–June 17, 1988, 14:47819 (R;US)
[Workshop on ion cooler ring experiments]: Foreign trip report, May 2, 1988–May 13, 1988, 14:47818 (R;US)
STRANGE PARTICLES
Strangeness production in Si + Au interactions at 14.6 GeV/c per nucleon, 14:48293 (R;US)
STRATEGIC DEFENSE INITIATIVE
See BALLISTIC MISSILE DEFENSE
STRATEGIC PETROLEUM RESERVE
Strategic Petroleum Reserve quarterly report, 14:47252 (R;US)
STRATOSPHERE
Ozone depletion, greenhouse gases, and climate change: Proceedings, 14:47924 (R;US)
STREAK CAMERAS
A microchannel plate intensified, subnanosecond, x-ray imaging camera, 14:47838 (R;US)
STREAMING (RADIATION)
See RADIATION STREAMING
STREAMS
[Effects of nutrient recycling and food chain length on resilience]: Foreign trip report, April 3–30, 1988, 14:47975 (R;US)
STRENGTH (COMPRESSION)
See COMPRESSION STRENGTH
STREPTOMYCES
Comparison of alkali and microbial solubilization of oxidized, low-rank coal, 14:46803 (RA;US)
STRESSES
Effective stress model for partially and fully saturated rocks, 14:48161 (R;US)
STRING MODELS
Evolution of cosmic string networks, 14:48218 (R;US)
The canonical structure of the manifestly supersymmetric string, 14:48384 (J;US)
Action Integral
Action for a non-Archimedean string and Brua-Tits trees, 14:48407 (RA;SU;In Russian)
Bordered surfaces, off-shell amplitudes, sewing, and string field theory, 14:48385 (R;US)
Bosons
BRS formulation of bosonic string theory and the properties of non-critical strings, 14:48374 (RA;JP)
Compactification
Application of superconformal symmetry to string compactification, 14:48363 (RA;JP)
Realistic superstring models. An introduction, 14:48364 (RA;JP)
Superpotential in Calabi-Yau compactification, 14:48380 (RA;JP)
Conformal Invariance
E_7 type modular invariant Wess-Zumino theory and Gepner's string compactification, 14:48366 (RA;JP)
Field Theories
Boundary and crosscap states in conformal field theories, 14:48413 (RA;JP)
Introduction to conformal field theories, 14:48411 (RA;JP)

Four-Dimensional Calculations
One-loop dynamics of four-dimensional string theory, 14:48370 (RA;JP)
Fragmentation
Fragmentation of cosmic-string loops, 14:48190 (R;US)
Gauge Invariance
Pre-geometrical field theory of open string, 14:48376 (RA;JP)
Lagrangian Function
One-particle-irreducible effective Lagrangian of string modes, 14:48375 (RA;JP)
Light Cone
Lorentz symmetry in the light-cone field theory of open and closed strings, 14:48373 (RA;JP)
Lorentz Invariance
Lorentz symmetry in the light-cone field theory of open and closed strings, 14:48373 (RA;JP)
Meetings
Proceedings of the summer workshop on superstrings, 14:48408 (R;JP)
Metrics
BRS formulation of bosonic string theory and the properties of non-critical strings, 14:48374 (RA;JP)
Perturbation Theory
On the domain of string perturbation theory, 14:48390 (R;XA)
Quantum Operators
Covariant operator formalism of bosonic string theory, 14:48369 (RA;JP)
Renormalization
Absence of wavefunction renormalization in Polyakov amplitudes, 14:48424 (J;NL)
Renormalization group flow and string dynamics, 14:48365 (RA;JP)
Sigma models and renormalization of string loops, 14:48388 (R;XA)
Riemann Sheet
Action for a non-Archimedean string and Brua-Tits trees, 14:48407 (RA;SU;In Russian)
Riemann Space
Parametrization of super light-cone diagrams with g-loops., 14:48412 (RA;JP)
Smooth Manifolds
Classifications of Z_N orbifold models, 14:48379 (RA;JP)
Zero mode and modular invariance in string on non-abelian orbifold, 14:48378 (RA;JP)
Supersymmetry
Evaluation of one-loop mass shifts in open superstring theory, 14:48371 (RA;JP)
Four dimensional open superstring model, 14:48367 (RA;JP)
On bosonization in BC system, 14:48372 (RA;JP;In Japanese)
Reducing the rank of gauge groups in orbifold compactification, 14:48415 (RA;JP)
Vertex Functions
Interacting models on the torus, 14:48368 (RA;JP)
Off-shell amplitude in Witten's bosonic string field theory, 14:48377 (RA;JP)

STRONTIUM COMPLEXES
Spectroscopic studies of cesium, strontium, and cerium (3) ion complexing with cobalt chlorinated dicarbollide (CCD) and hexapolyethylene glycol (HPEG) in nitrobenzene, 14:47517 (RA;SU;In Russian)

STRONTIUM OXIDES
A fermi liquid electric structure and the nature of the carriers in high-T_c cuprates: A photoemission study, 14:48531 (R;US)
Effects of shock-modification on superconductivity in $Tl_2Ca_2Ba_2Cu_3O_y$ and $Bi_2CaSr_2Cu_2O_x$, 14:47404 (R;US)

STRUCTURAL MATERIALS
See BUILDING MATERIALS

STRUCTURES (BUILDINGS)
See BUILDINGS

STRUCTURES (MECHANICS)
See MECHANICAL STRUCTURES

STYRENE POLYMERS
See POLYSTYRENE

SUBBITUMINOUS COAL
Coal fragmentation in a fluidized bed combustor, 14:46868 (BA;US)
Correlations for effects of coal type and pressure on tar yields from rapid devolatilization, 14:46853 (BA;US)
Depolymerization of low-rank coals by a unique microbial consortium, 14:46801 (RA;US)
Rapid pyrolysis and combustion of pulverized Montana Rosebud subbituminous coal, 14:46864 (BA;US)

SUBMARINES
Instructions for using SOW Pk program, 14:48754 (R;US)

SUBURBS
See URBAN AREAS

SUDDEN COMMENCEMENTS
Solar-Geophysical Data Number 535, March 1989. Part 1 (prompt reports). Data for February, January 1989, and late data, 14:48221 (R;US)

SUDDEN IONOSPHERIC DISTURBANCE
Solar-Geophysical Data Number 534, February 1989. Part 1 (prompt reports). Data for January 1989, December 1988, and late data, 14:48219 (R;US)
Solar-Geophysical Data Number 535, March 1989. Part 1 (prompt reports). Data for February, January 1989, and late data, 14:48221 (R;US)

SULFATES
Air quality studies in the western United States, 14:47925 (R;US)

SULFUR
Extruded coal capsules for transport in fiber-water flow: Final technical report, 14:46845 (R;US)
Transport properties of thermally grown Cr_2O_3, 14:47388 (R;US)

SULFUR 32 REACTIONS
Results from WA80 on transverse energy production, fluctuations in multiparticle production, and γ/π^0 ratios, 14:48444 (J;NL)

SULFUR DIOXIDE
Cost-effective sulfur control strategies for the Great Plains gasification project, 14:46825 (BA;US)
Increased SO_2 removal with the addition of alkali metals and chromium to calcium-based sorbents, 14:46876 (BA;US)
Stationary combustion: The environmental leitmotiv, 14:46846 (BA;US)

SULFUR ISOTOPES
Development and application of stable isotope mass transfer reaction path models, 14:47058 (RA;US)

SULFUR OXIDES
1988 annual report of the Integrated Forest Study, 14:47933 (R;US)

SULFUR SULFIDES
See SULFUR

SULFURIC ACID
Roles of pH, titratable acid, and specific chemical composition in mediating effects of acid aerosols on the airways. Final report, 14:48147 (R;US)

SUN
Differences between line bisectors in quiet and active sun, 14:48174 (R;US)
Effects of Cosmions upon the structure and evolution of very low mass stars, 14:48189 (R;US)

SUNSPOTS
Ionospheric scintillations/TEC and in-situ density measurements at an auroral location in the European sector. Environmental research papers, 2 October 1986-31 July 1987, 14:48232 (R;US)
Solar-Geophysical Data Number 535, March 1989. Part 1 (prompt reports). Data for February, January 1989, and late data, 14:48221 (R;US)

SUPER HIGH FREQUENCY RADIATION
See RADIOWAVE RADIATION

SUPERCOMPUTERS
Design and implementation of a parallel computer for expert system applications, 14:48739 (BA;US)
Parallelism in rule-based systems, 14:48738 (BA;US)
Supercomputers, architectures and applications, 14:48734 (R;NL;In Dutch)

SUPERCONDUCTING CABLES
Rational design of high-current cable-in-conduit superconductors, 14:48670 (R;US)
The characterization of Nb_3Sn superconductors for use in magnets of 19 T and greater, 14:47726 (R;US)

SUPERCONDUCTING DEVICES
Sensors and detectors based on superconducting devices. January 1970-June 1988 (Citations from the COMPENDEX data base). Report for January 1970-June 1988, 14:47721 (R;US)
Sensors and detectors based on superconducting devices. July 1988-June 1989 (Citations from the COMPENDEX data base). Report for July 1988-June 1989, 14:47722 (R;US)

SUPERCONDUCTING MAGNETS
Fine filament NbTi conductors for the SSC, 14:47732 (J;US)
Method of transforming a passive ferromagnetic material into a permanent magnet, 14:47735 (P;US)
Superconducting shielded PYX PPM (periodic permanent magnet) stacks, 14:47734 (P;US)
Superconducting shielded PYX PPM stacks, 14:47733 (P;US)
The International Thermonuclear Experimental Reactor (ITER): Design and materials selection, 14:48695 (R;US)

SUPERCONDUCTING QUANTUM INTERFERENCE DEVICES
See SQUID DEVICES

SUPERCONDUCTING SUPER COLLIDER
Fine filament NbTi conductors for the SSC, 14:47732 (J;US)
Pileup at the SSC [Superconducting Super Collider], 14:48291 (R;US)

SUPERCONDUCTING WIRES
Method of mass-producing superconducting persistent current rings, 14:47736 (P;US)
Thermal conduction of SSC [Superconducting Super Collider] wire, 14:47352 (R;US)

SUPERCONDUCTIVITY
Calculations of resistivity and superconducting T_c in transition metals, 14:48536 (BA;US)
Complex susceptibility and magnetic properties of (Bi,Pb)SrCaCuO, 14:47390 (RA;AT;In German)
Further studies on possible coexistence of antiferromagnetism and superconductivity in 2D Heisenberg model, 14:48530 (R;XA)
Infrared reflection and magnetic susceptibility of $Ba_{1-x}K_xBiO_{3-\delta}$, 14:47424 (RA;AT;In German)
Pseudopotential calculations of structural properties of solids, 14:48526 (BA;US)
Statement on superconductivity, 14:47714 (R;US)

SUPERCONDUCTORS
Fundamental and applied studies of explosively fabricated high-temperature superconducting fixtures. Quarterly technical report, 1 September-31 November 1988, 14:47386 (R;US)
Hall effect in ceramic high-temperature superconductors, 14:47391 (RA;AT;In German)
High-temperature ceramic superconductors. Report for 1 January-31 March 1989, 14:47713 (R;US)
High-temperature superconductors: physical properties of single crystalline- and polycrystalline samples, and of thin films, 14:47423 (RA;AT;In German)
Influence of fluctuations on the phase transformations in the superconductor, 14:47358 (RA;AT;In German)
Positron annihilation radiation in high-temperature superconductors, 14:47827 (RA;AT;In German)
Statement on superconductivity, 14:47714 (R;US)
Status of high-temperature superconductors research in Austria, 14:47392 (RA;AT;In German)
Structure-property relationships as an aid in the rational design of β-$(ET)_2X$ organic superconductors, 14:47347 (R;US)
[Neutron scattering experiments on high-temperature superconducting materials]: Foreign trip report, September 13, 1988–October 4, 1988, 14:48533 (R;US)

SUPERCRITICAL FLOW
See TURBULENT FLOW

SUPERFUND
Toxic chemical report, first annual: a summary of information contained in the toxic chemical report forms for calendar year 1987. Final report, 14:47226 (R;US)
Toxicological profile for cadmium. Final report, 14:48152 (R;US)
Toxicological profile for methylene chloride. Final report, 14:48151 (R;US)

Implementation
Local implementation by New England municipalities of the Emergency Planning and Community Right-To-Know Act of 1986 (Title 3 of SARA) (Superfund Amendments and Reauthorization Act). Technical report (Final), 14:47228 (R;US)

Remedial Action
Superfund Record of Decision (EPA Region 1): Groveland Wells Nos. 1 and 2 Site, Valley site source-control organic operable unit, Groveland, Massachusetts (first remedial action), September 1988, 14:48057 (R;US)
Superfund Record of Decision (EPA Region 1): Landfill and Resource Recovery, Rhode Island (first remedial action), September 1988. Final report, 14:48007 (R;US)
Superfund Record of Decision (EPA Region 1): Old Springfield Landfill, Vermont (first remedial action), September 1988, 14:48080 (R;US)
Superfund Record of Decision (EPA Region 1): Rose Disposal Pit, Lanesborough, Massachusetts (first remedial action) September 1988. Final report, 14:48005 (R;US)
Superfund Record of Decision (EPA Region 2): Asbestos Dump, Millington Site, Millington, New Jersey (first remedial action), September 1988, 14:47999 (R;US)
Superfund Record of Decision (EPA Region 2): Ewan Property, Burlington County, New Jersey (first remedial action), September 1988, 14:48004 (R;US)
Superfund Record of Decision (EPA Region 3): Dorney Road Landfill Superfund Site, Lehigh County, Pennsylvania (first remedial action), September 1988, 14:48002 (R;US)
Superfund Record of Decision (EPA Region 3): Drake Chemical Site, Lock Haven, Pennsylvania (third remedial action), September 1988. Final report, 14:48079 (R;US)
Superfund Record of Decision (EPA Region 3): Palmerton Zinc Pile, Pennsylvania (second remedial action), September 1988, 14:47970 (R;US)
Superfund Record of Decision (EPA Region 3): Wildcat Landfill, Kent County, Delaware (first remedial action), June 1988, 14:48003 (R;US)
Superfund Record of Decision (EPA Region 4): Celanese Fibers Operations, Shelby, North Sarolina (first remedial action), March 1988, 14:48078 (R;US)
Superfund Record of Decision (EPA Region 4): Flowood, Rankin County, Mississippi (first remedial action), September 1988. Final report, 14:48077 (R;US)
Superfund Record of Decision (EPA Region 5): Kummer Sanitary Landfill, Beltrami County, Minnesota (second remedial action) September 1988, 14:48006 (R;US)
Superfund Record of Decision (EPA Region 5): Republic Steel Quarry Site, Elyria, Ohio (first remedial action), September 1988. Final report, 14:48075 (R;US)
Superfund Record of Decision (EPA Region 5): Velsicol Chemical Corporation, Marshall, Illinois (first remedial action), September 1988. Final report, 14:48076 (R;US)
Superfund Record of Decision (EPA Region 6): French Limited, Texas (first remedial action), March 1988. Final report, 14:48008 (R;US)
Superfund Record of Decision (EPA Region 6): Sol Lynn/Industrial Transformers, Texas (first remedial action), September 1988. Final report, 14:48009 (R;US)
Superfund Record of Decision (EPA Region 7): Shenandoah Stables, Missouri (first remedial action), July 1988, 14:48010 (R;US)
Superfund Record of Decision (EPA Region 9): MGM Brakes site, Cloverdale, California (first remedial action), September 1988. Final report, 14:48054 (R;US)
Superfund Record of Decision (EPA Region 9): Operating Industries, Inc. (OII), Monterey Park, California (third remedial action), September 1988, 14:48001 (R;US)
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Toxic Materials

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Toxic Release Inventory (TRI), United States and territories, 1987 (Lotus 1-2-3) (for microcomputers). Data file, 14:48116 (R;US)

SUPERGRAVITY

16/16, N=1 supergravity: the low energy limit of the superstring, 14:48564 (RA;PL)

Restrictions on particle masses in supersymmetry, 14:48569 (RA;AT;In German)

SUPERLATTICES

Investigations of the quantum photovoltaic effect in InAs-GaSb semiconductor superlattices, 14:47413 (R;US)

SUPERSYMMETRY

Superconformal symmetry and superstring compactification, 14:48383 (J;US)

Supersymmetric flavor and CP violation, 14:48361 (RA;PL)

The canonical structure of the manifestly supersymmetric string, 14:48384 (J;US)

SUPERVOLTAGE RADIOTHERAPY

See RADIOTHERAPY

SUPPORTS

Disassembly and defueling of the upper core support assembly, 14:47190 (J;US)

SURFACE COATING

Suppression of volume breakdown in vacuum with coatings, 14:47448 (R;US)

SURFACE CONTAMINATION

The TMI-2 [Three Mile Island Unit 2] reactor building gross decontamination experiment: Effects on loose-surface contamination levels, 14:47173 (J;US)

SURFACE EXPLOSIONS

Visibility in an atmospheric nuclear dust cloud. Master's thesis, 14:47867 (R;US)

SURFACE WATERS

Acidification and water pathways. Vol. II, 14:48012 (R;NO)

Federalism and the surface-water program. Technical report, 14:48059 (R;US)

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SURFACES

Paint coatings: Controlled field and chamber experiments, 14:47947 (R;US)

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SURRY POWER STATION UNIT-1

See SURRY-1 REACTOR

SURRY POWER STATION UNIT-2

See SURRY-2 REACTOR

SURRY-1 REACTOR

Investigation of reactor coolant system depressurization as an accident management strategy, 14:47136 (R;US)

SURRY-2 REACTOR

Investigation of reactor coolant system depressurization as an accident management strategy, 14:47136 (R;US)

SURRY-3 REACTOR

Investigation of reactor coolant system depressurization as an accident management strategy, 14:47136 (R;US)

SURRY-4 REACTOR

Investigation of reactor coolant system depressurization as an accident management strategy, 14:47136 (R;US)

SUSPENSIONS (FUEL)

See FUEL SLURRIES

SWEAT GLANDS

See SKIN

SWIMMING

See EXERCISE

SWINE

Radiocesium binding substances in livestock production, 14:48122 (R;DE;In German)

SWIRL FLOW

See VORTEX FLOW

SWITCHING DIODES

Recombination centres in electron- and neutron irradiated Si diodes, 14:47840 (RA;AT;In German)

SYMMETRY BREAKING

E_6 symmetry breaking in the superstring theory, 14:48362 (RA;PL)

Triviality of the Higgs field, 14:48382 (J;US)

SYMPOSIA

See MEETINGS

SYNCHROTRON RADIATION

Report of the plan meeting on use of synchrotron radiation from the Tristan Main Ring, 14:47817 (R;JP;In Japanese)

SYNCHROTRON RADIATION SOURCES

Considerations in SR facility planning: Technical options in the design of an intermediate energy synchrotron radiation source, 14:47780 (R;US)

SYNTHESIS GAS

Ignition processes in carbon-monoxide-hydrogen-oxygen mixtures, 14:47687 (BA;US)

Non-premixed turbulent CO/H_2 flames at local extinction conditions, 14:47589 (BA;US)

Spontaneous Raman Measurements in turbulent $CO/H_2/N_2$ flames near extinction, 14:47590 (BA;US)

The inhibiting effect of CF_3H on the structure of a stoichiometric $H_2/CO/O_2/Ar$ flame, 14:47678 (BA;US)

The structure of turbulent nonpremixed flames, 14:47576 (BA;US)

SYNTHETIC FUELS REFINERIES

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T

T CODES

Development of the computer code TRANS-ACE for analysing radioactive materials transport in reprocessing plants under accidental conditions, 14:46931 (R;JP;In Japanese)

Vectorization of nuclear codes 88-1. SRAC, CITATION, TWOTRAN-II, COREBN, CITATION-FBR, 14:47104 (R;JP;In Japanese)

T MATRIX

See S MATRIX

TACHYONS

Divergences and involution-dependent constants, 14:48422 (J;US)

TAILINGS

Microbial dissolution of toxic metals from coal residues, 14:46839 (RA;US)

TANK FARMS

See STORAGE FACILITIES

TANKS

Underground storage tanks: State regulations and compliance strategies, 14:46995 (RA;US)

TANTALUM

Calculations of resistivity and superconducting T_c in transition metals, 14:48536 (BA;US)

Search for crystal-catalyzed fusion reactions, 14:48674 (RA;AT;In German)

Temperature and amplitude dependence of internal friction in tantalum, niobium, dysprosium irradiated with electrons, 14:47366 (RA;SU;In Russian)

The HEL [Hugoniot Elastic Limit] and rate-dependent yield behavior, 14:47370 (R;US)

TANTALUM CARBIDES
High-temperature materials compatibility testing of refractory crucible materials: TaC, Y_2O_3, Y_2O_3-coated MgO, and BN, 14:46930 (R;US)
TAR
Updraft gasification of waste fuels, 14:47020 (R;FI;In Finnish)
TAR SANDS
See OIL SANDS
TARGETS
Target acquisition methodology enhancement (TAME). Final report, March 1988-March 1989, 14:47868 (R;US)
TATB
Carbon in detonations, 14:47856 (R;US)
Lagrangian analysis of MIV [Magnetic Impulse-Velocity] gauge experiments on PBX 9502 using the mass-displacement moment function, 14:47858 (R;US)
Shock initiation of LX-17 as a function of its initial temperature, 14:47864 (R;US)
VISAR wave profile measurements in supra-compressed HE, 14:47863 (R;US)
TAU LEPTONS
See TAU PARTICLES
TAU PARTICLES
Polarization in tau-lepton production at LEP and $\sin^2\theta_W$, 14:48355 (RA;SU)
TAUONS
See TAU PARTICLES
TEARING INSTABILITY
Symmetry breaking bifurcations of a current sheet, 14:48584 (R;AU)
TECHNETIUM
Review of some aspects of the solution chemistry of technetium, 14:47481 (R;GB)
TECHNICAL INFORMATION CENTER
Program distribution for unclassified scientific and technical reports: Instructions and category scope notes: Revision 75, 14:48741 (R;US)
TECHNOLOGY TRANSFER
Analysis and technology transfer: Annual report 1988: Buildings and Community Systems, 14:47237 (R;US)
TECHNOLOGY UTILIZATION
Development of advanced technology for scientific research, 14:47240 (R;JP;In Japanese)
TEKTITES
New approach to the origin of the tektite in China, 14:48215 (RA;US)
Tektites: Origin as melts produced by the impact of small projectiles onto dry targets, 14:48212 (RA;US)
TELLURIDES
Change of p-n junction photoelectric properties during semiconductor transition in to ferroelectric phase, 14:48514 (RA;SU;In Russian)
TELLURIUM COMPOUNDS
NQR and diffuse reflection spectra of rhenium chalcochloride complexes, 14:47510 (RA;SU;In Russian)
TEMPERATURE (ION)
See ION TEMPERATURE
TERATOGENS
[Short-term assays for detecting environmental mutagens, carcinogens, and teratogens]: Foreign trip report, February 4–28, 1989, 14:48145 (R;US)
TERBIUM BASE ALLOYS
Magnetic order and magnetic behavior of the polished amorphous eutectic alloys $Tb_{65}Cu_{35}$ and $Er_{69.5}Cu_{30.5}$ - influence of a magnetic field, 14:47334 (R;FR)
TERPENES
Kinetics and quantitative analysis of the isomerization and aromatization of fossil steroid hydrocarbons within experiments and in naturally matured sample sequences, 14:46889 (R;DE;In German)
TERRESTRIAL BACKGROUND
See BACKGROUND RADIATION
TERRESTRIAL ECOSYSTEMS
ELF (extremely low frequency) communications system ecological monitoring program: Summary of 1987 progress. Technical report, 1 January-31 December 1987, 14:48159 (R;US)
TERTIARY RECOVERY
See ENHANCED RECOVERY
TEST FACILITIES
Measurement of angular differential cross sections at the SSL Atomic Scattering Facility, 14:48274 (RA;US)
TEST WELLS
See EXPLORATORY WELLS
TESTING (BIOLOGICAL)
See BIOASSAY
TESTING (MATERIALS)
See MATERIALS TESTING
TETRAHYDRONAPHTHALENE
See TETRALIN
TETRALIN
[Free radical and rearrangement reactions in coal liquefaction], 14:46814 (R;US)
TEVATRON
See FERMILAB TEVATRON
TEXACO GASIFICATION PROCESS
Phase I, Volume I, Program summary and PDU [process development unit] operations: Topical report, October 1987–January 1989, 14:46816 (R;US)
TFTR DEVICE
See TFTR TOKAMAK
TFTR REACTORS
See TFTR TOKAMAK
TFTR TOKAMAK
Design of the TFTR [Tokamak Fusion Test Reactor] maintenance manipulator, 14:48703 (J;US)
THALLIUM IODIDES
^{127}I NQR study of holmium iodide compounds with monovalent metals (Metals: K, Rb, Cs, Ag, Tl.), 14:47515 (RA;SU;In Russian)
^{79,81}Br, ^{127}I NQR study of Tl-containing inorganic compounds, 14:47502 (RA;SU;In Russian)
THALLIUM OXIDES
Effects of shock-modification on superconductivity in $Tl_2Ca_2Ba_2Cu_3O_y$ and $Bi_2CaSr_2Cu_2O_x$, 14:47404 (R;US)
THERMAL ALTERATION
See MATURATION
THERMAL ANALYSIS
Three dimensional thermal analysis of rocket thrust chambers, 14:47754 (R;US)
THERMAL CONDUCTION
Numerical studies of identification in nonlinear distributed parameter systems. Final report, 14:48574 (R;US)
THERMAL CONDUCTIVITY
Model for roof thermal performance, 14:47270 (R;US)
THERMAL ENERGY STORAGE EQUIPMENT
Commercialization of aquifer thermal energy storage technology, 14:47202 (R;US)
THERMAL POLLUTION (AIR)
See AIR POLLUTION
THERMAL POLLUTION (WATER)
See WATER POLLUTION
THERMOELECTRIC COOLERS
Environmental test report on the CTI-Cryogenics 1-watt integral Stirling cooler (long-life HD-1033d). Final report, 16 June-24 July 1988, 14:47715 (R;US)
MM & T for linear resonant cooler. Volume 1. Final report, October 1984-September 1986, 14:47712 (R;US)
THERMOLUMINESCENT DOSEMETERS
Development of a dose algorithm for the modified panasonic UD-802 personal dosimeter used at three mile island, 14:47176 (J;US)
Surface activity characterization with TLD rings, 14:47174 (J;US)
THERMONUCLEAR DEVICES
Collective processes with energetic particles in fusion plasmas, 14:48590 (RA;AT;In German)

User's manual of self learning gas puffing system for plasma density control, 14:48726 (R;JP;In Japanese)

THERMONUCLEAR FUELS
Data libraries for fusion reactions in fusion fuels, 14:48675 (RA;AT;In German)

THERMONUCLEAR POWER PLANTS
Environmental impact of fusion power, 14:48698 (J;GB)

THERMONUCLEAR REACTIONS
Data libraries for fusion reactions in fusion fuels, 14:48675 (RA;AT;In German)
Highlights of papers presented at the workshop on cold fusion phenomena, 14:48582 (R;US)
Transferreactions at thermonuclear energies, 14:48677 (RA;AT;In German)

THERMONUCLEAR REACTOR MATERIALS
Need for and requirements for neutron irradiation facility for fusion materials testing, 14:48669 (R;US)
[Reactor irradiation techniques]: Foreign trip report, November 7–11, 1988, 14:48689 (R;US)

THERMONUCLEAR REACTORS
Impact transport of reaction products in magnetized fusion plasmas, 14:48592 (RA;AT;In German)
STOA experiment in the European Parliament. The fusion project, 14:48699 (J;GB)
[International symposium on fusion nuclear technology, Tokyo, Japan, April 10, 1988]: Foreign trip report, 14:48688 (R;US)

THERMONUCLEAR WEAPONS
See NUCLEAR WEAPONS

THIN FILMS
High-temperature superconductors: physical properties of single crystalline- and polycrystalline samples, and of thin films, 14:47423 (RA;AT;In German)
[Ion beam deposition of epitaxial germanium and gallium arsenide layers]: Foreign trip report, June 2, 1989–June 18, 1989, 14:48521 (R;US)

THIOBACILLUS FERROXIDANS
Bacterial desulfurization of Turkish lignites, 14:46808 (RA;US)
Desulfurization of coal by bacterial means, 14:46810 (RA;US)
Microbial degradation of organosulfur compounds: Implications for the microbial desulfurization of coal, 14:46809 (RA;US)

THIOBACILLUS OXIDANS
Bacterial desulfurization of Turkish lignites, 14:46808 (RA;US)

THIONYL CHLORIDES
Advanced calcium-thionyl chloride high-power battery. Final report, 23 December 1987-22 December 1988, 14:47204 (R;IL)

THIOPHENE
Interactive chemistry of coal-petroleum processing: Quarterly report, March 16, 1989–June 15, 1989, 14:46898 (R;US)

THIOPHENES
See POLYCYCLIC SULFUR HETEROCYCLES

THOMSON SCATTERING
Thomson scattering system for TORTUS tokamak, 14:48619 (RA;AU)

THORIUM
Calorimetric and magnetic properties in uranium -intermetallic compounds, 14:47353 (RA;AT;In German)
Ultrapure materials for alpha particle-sensitive applications, 14:47555 (J;US)

THORIUM 217
Properties of $15/2^-$ states in ^{215}Ra and ^{217}Th; evaluation of the $15/2^-$ to $9/2^+$ E3 strength in N=127 isotones, 14:48456 (R;AU)

THORIUM D
See LEAD 208

THREE MILE ISLAND-2 REACTOR
Corium
INEL [Idaho National Engineering Laboratory] hot shop contamination control during TMI-2 [Three Mile Island Unit 2] core debris handling, 14:47198 (J;US)

Meltdown
The microstructural and microchemical characterization of samples from the TMI-2 core, 14:47165 (J;NL)

Reactor Accidents
Application of three-dimensional computer solids modeling to TMI-2 [Three Mile Island Unit 2] defueling activities, 14:47197 (J;US)
Computer system development to support TMI-2 [Three Mile Island Unit 2] radiological controls, operations, and records management activities, 14:47178 (J;US)
Control of the TMI-2 [Three Mile Island Unit 2] reactor building environment, 14:47183 (J;US)
Criticality analysis support for TMI-2 [Three Mile Island Unit 2] fuel removal operations, 14:47195 (J;US)
Criticality prevention during postaccident decontamination of TMI-2 [Three Mile Island Unit 2] plant systems, 14:47196 (J;US)
Development of a dose algorithm for the modified panasonic UD-802 personal dosimeter used at three mile island, 14:47176 (J;US)
Development of an underwater remote manipulator system for use in TMI-2 [Three Mile Island Unit 2] reactor defueling, 14:47192 (J;US)
Disassembly and defueling of the TMI-2 [Three Mile Island Unit 2] reactor vessel lower core support assembly, 14:47189 (J;US)
Disassembly and defueling of the upper core support assembly, 14:47190 (J;US)
Dosimetry studies pertaining to the accident at TMI-2 [Three Mile Island Unit 2], 14:47179 (J;US)
Emergency response planning in Pennsylvania, 14:47185 (J;US)
Environmental measurements during the TMI-2 [Three Mile Island Unit 2] accident, 14:47171 (J;US)
MARCH calculations performed for the TMI-2 [Three Mile Island Unit] analysis exercise program, 14:47167 (J;US)
Operations and achievements of remote equipment at TMI-2 [Three Mile Island Unit 2], 14:47191 (J;US)
Performance of the automated cutting equipment system during the plasma cutting of the TMI-2 [Three Mile Island Unit 2] lower core support assembly, 14:47193 (J;US)
Personnel contamination protection techniques applied during the TMI-2 [Three Mile Island Unit 2] cleanup, 14:47182 (J;US)
Programmatic changes due to TMI-2 [Three Mile Island Unit 2]: Accident planning, 14:47187 (J;US)
Radiation protection training then and now, 14:47181 (J;US)
Radiological conditions and experiences in the TMI-2 [Three Mile Island Unit 2] auxiliary building, 14:47169 (J;US)
Robotic delivery system for plasma cutting of the TMI-2 [Three Mile Island Unit 2] lower core support assembly, 14:47731 (J;US)
Summary of the results of the TMI-2 analysis exercise, 14:47168 (J;US)
Summary, retrospect, and evolution of mobile remote systems, 14:47194 (J;US)
Surface activity characterization with TLD rings, 14:47174 (J;US)
TMI [Three Mile Island] and the environment, 14:47172 (J;US)
The Department of Energy response to TMI [Three Mile Island], 14:47188 (J;US)
The TMI-2 [Three Mile Island Unit 2] reactor building gross decontamination experiment: Effects on loose-surface contamination levels, 14:47173 (J;US)
The Three Mile Island Unit 2 accident and its impact on the NRC, 14:47186 (J;US)
The role of radiation instruments in the recovery of TMI-2 [Three Mile Island Unit 2], 14:47184 (J;US)
The significance of radiological control documentation in litigation, 14:47177 (J;US)
Three mile island unit 2 postaccident reactor building entry program, 14:47170 (J;US)
Using ex-core neutron detectors to estimate fuel quantities in the reactor vessel lower head, 14:47175 (J;US)
Worker exposures during the TMI-2 [Three Mile Island Unit 2] recovery, 14:47180 (J;US)

Reactor Core Restraints
Robotic delivery system for plasma cutting of the TMI-2 [Three Mile Island Unit 2] lower core support assembly, 14:47731 (J;US)

Sampling
The microstructural and microchemical characterization of samples from the TMI-2 core, 14:47165 (J;NL)
THYROID
Thyroid dose from ^{131} iodine of the population in Poland following the Chernobyl accident, 14:47129 (R;FR;In French)
TIGHT SANDS
See SANDSTONES
TIN
Measurement of reduced electric octupole transition probabilities B(E3;O_1^+ -> 3_1^-), for ^{118,120,122}Sn, 14:48449 (R;AU)
TIN IODIDES
^{79,81}Br, ^{127}I NQR study of TI-containing inorganic compounds, 14:47502 (RA;SU;In Russian)
TIN ISOTOPES
[A proposal for research to use the GANIL accelerator facility at Caen, France, May 30–31, 1988]: Foreign trip report, 14:48434 (R;US)
[Isoscalar quadrupole resonances in ^{90,96}Zr and ^{112,118,124}Sn by inelastic scattering of ^{17}O ions]: Foreign trip report, November 5–December 13, 1988, 14:48452 (R;US)
TITANATES
Calcium uranium titanate - a new pyrochlore, 14:47554 (R;AU)
Inclusion tuning of nonlinear optical materials: Sorbates in the KTP structure, 14:47529 (J;US)
Phase I, Volume I, Program summary and PDU [process development unit] operations: Topical report, October 1987–January 1989, 14:46816 (R;US)
TITANIUM
Charge state dependence of K X-ray production in thin targets by multicharged silicon ions, 14:48281 (J;NL)
Powder morphology effects in the ignition of titanium-based pyrotechnics, 14:47860 (R;US)
Reaction rates in cold fusion, 14:48676 (RA;AT;In German)
Search for crystal-catalyzed fusion reactions, 14:48674 (RA;AT;In German)
TITANIUM ALLOYS
Annealing of radiation defects in region of 3 stage in nickel and in nickel-titanium alloy, 14:47361 (RA;SU;In Russian)
Tensile behavior of helium-implanted and neutron-irradiated V-15 Cr-5 Ti, 14:48697 (J;US)
Thermal conduction of SSC [Superconducting Super Collider] wire, 14:47352 (R;US)
TITANIUM BASE ALLOYS
Polishing methods for metallic and ceramic transmission electron microscopy specimens: Revision 1, 14:47329 (R;US)
The HEL [Hugoniot Elastic Limit] and rate-dependent yield behavior, 14:47370 (R;US)
TLD (DOSEMETERS)
See THERMOLUMINESCENT DOSEMETERS
TLD SYSTEMS
See THERMOLUMINESCENT DOSEMETERS
TMPN
See HYDROXY COMPOUNDS
TNT
Carbon in detonations, 14:47856 (R;US)
Conventional weapons demilitarization: A health and environmental effects data base assessment: Methods for estimating multi-pathway exposures to environmental contaminants, Final report, Phase 2, 14:48155 (R;US)
VISAR wave profile measurements in supra-compressed HE, 14:47863 (R;US)
TOKAMAK DEVICES
Comparison of ballooning mode stability properties of tokamaks with circular and elliptic cross sections with the same poloidal flux, 14:48659 (R;US)
Fusion plasma theory: Task 3, Auxiliary heating in tokamaks: Progress report, [1988–1989], 14:48585 (R;US)
On bootstrap currents in toroidal systems, 14:48644 (R;DE)
Prospects for fusion power: recent reports in Europe, 14:48680 (RA;AU)
Study on poloidal field coil optimization and equilibrium control of ITER, 14:48686 (R;JP)
Tokamaks, 14:48664 (B;US)
Toroidal parallel flow in Tokamaks, 14:48589 (RA;AT;In German)
TOKAMAK FUSION TEST REACTOR
See TFTR TOKAMAK
TOLUENE
A shock tube study on the thermal decomposition of toluene and of the phenyl radical at high temperatures, 14:47633 (BA;US)
TOPONIUM
Heavy quarkonia in smoothed potential, 14:48346 (RA;SU;In Russian)
TOROIDAL CONFIGURATION
Toroidal parallel flow in Tokamaks, 14:48589 (RA;AT;In German)
TORQUE
Transient phenomena in asynchronous motor drive, 14:47082 (R;FI;In Finnish)
TOTAL-ABSORPTION SPECTROMETERS
See SHOWER COUNTERS
TOXIC MATERIALS
Chesapeake bay basinwide toxics reduction strategy: an agreement commitment report from the Chesapeake Executive Council. Final report, 14:48052 (R;US)
Estimating air-toxics emission from coal and oil combustion sources. Final report, 14:47953 (R;US)
Locating and estimating air-toxics emissions from municipal-waste combustors. Final report, August 1988-March 1989, 14:47955 (R;US)
TOXLEARN: Microcomputer-based training for TOXLINE. Software, 14:48114 (R;US)
Toxic Release Inventory (TRI), United States and Territories, 1987 (DBASE III) (for microcomputers). Data file, 14:48115 (R;US)
Toxic Release Inventory (TRI), United States and territories, 1987 (Lotus 1-2-3) (for microcomputers). Data file, 14:48116 (R;US)
Toxic chemical report, first annual: a summary of information contained in the toxic chemical report forms for calendar year 1987. Final report, 14:47226 (R;US)
Toxicity Reduction Evaluation protocol for municipal wastewater treatment plants. Report for 1 February-30 September 1988, 14:48045 (R;US)
TOXICITY
TOXLEARN: Microcomputer-based training for TOXLINE. Software, 14:48114 (R;US)
[Regulation of tetrahydropterins in Drosophila: Research review]: Foreign trip report, April 5, 1989–May 5, 1989, 14:48091 (R;US)
TRAINING-RESEARCH REACTOR KYOTO
See KUR REACTOR
TRANSFER (HEAT)
See HEAT TRANSFER
TRANSFER (IN ENVIRONMENT)
See RADIONUCLIDE MIGRATION
TRANSFER (MASS)
See MASS TRANSFER
TRANSITION ELEMENT COMPOUNDS
Complexone application to sample preparation for an x-ray fluorescence analysis, 14:47475 (RA;SU;In Russian)
TRANSITION ELEMENTS
Electronic structure of transition metal alloys and intermetallics: Charge transfer and its inplications for Moessbauer effect measurements, 14:47331 (R;US)
Noble metals in mid-ocean ridge volcanism: A significant fractionation of gold with respect to platinum group metals, 14:48193 (RA;US)
TRANSITION METALS
See TRANSITION ELEMENTS
TRANSITION RADIATION DETECTORS
A high rate transition radiation detector for particle identification in a hadron beam, 14:47825 (R;US)
TRANSMISSION (HEAT)
See HEAT TRANSFER
TRANSMISSION LINES
See POWER TRANSMISSION LINES
TRANSPORT
Methods for municipal traffic safety work - improvement of traffic environment. A literature survey, 14:47280 (R;FI;In Finnish)
TRANSPORT (RADIATION)
See RADIATION TRANSPORT

TRANSPORT REGULATIONS
DOT/OSHA/EPA (Department of Transportation/Occupational Safety and Health Administration/Environmental Protection Agency) integrated DOE (Department of Energy) transportation training, 14:47219 (RA;US)
TRANSURANIUM ELEMENTS
Magnetic measurements of the transuranium elements: Progress report, January 1, 1989–December 31, 1989, 14:47350 (R;US)
[Auger effect symposium]: Foreign trip report, March 30, 1989–April 11, 1989, 14:48277 (R;US)
TRANSURANIUM WASTES
See ALPHA-BEARING WASTES
TREES
Economic pre-feasibility study: large-scale methanol fuel production from surplus Canadian forest biomass. Part 1, summary report, 14:47026 (R;CA)
Open-top chamber experiments for investigating the effect of pollutants on growth and health of forest (feasibility study), 14:48142 (R;DE;In German)
Studies of environmental radioactivity in Cumbria. Pt. 13. Measurements of carbon-14 in tree rings from trees growing in the Sellafield area, 14:47959 (R;GB)
TRIGA-2-ROME REACTOR
Mathematical model for real-time diagnostics of TRIGA RC-1 system, 14:47111 (R;IT)
TRINITROTOLUENE
See TNT
TRIPLET PARTICLES
See QUARKS
TRISTAN PROJECT
See TRISTAN STORAGE RINGS
TRISTAN STORAGE RINGS
Report of the plan meeting on use of synchrotron radiation from the Tristan Main Ring, 14:47817 (R;JP;In Japanese)
TRITIUM
Experimental investigations on muon-catalyzed nuclear fusion, 14:48673 (RA;AT;In German)
Measurement of sticking probability in muon-catalysed fusion, 14:48678 (RA;AT;In German)
TRITIUM SYSTEMS TEST ASSEMBLY
Code development for analysis of TSTA compound cryopumps, 14:48702 (J;US)
Experience of TSTA milestone runs with 100 grams-level of tritium, 14:47166 (J;US)
Single column and two-column H-D-T distillation experiments at TSTA, 14:48700 (J;US)
TROPICAL REGIONS
[Collection of data on tropical forest inventories, Rome, Italy, March 20–25, 1989]: Foreign trip report, 14:47035 (R;US)
TRU WASTES
See ALPHA-BEARING WASTES
TRX-1
See REVERSE-FIELD PINCH
TSCHEBYSCHEFF APPROXIMATION
See POLYNOMIALS
TSTA
See TRITIUM SYSTEMS TEST ASSEMBLY
TUBES (CONDUITS)
See PIPES
TUFF
Containment analyses for the Mission Ghost cavity event, 14:47871 (RA;US)
Effects of late time creep and cavity depressurization on the residual stress field, 14:47879 (RA;US)
Predicting the response of shock-conditioned tuff from Rainier Mesa using laboratory tests, 14:47887 (RA;US)
Recent material test data and material response models for damage in tuff and grouts, 14:47886 (RA;US)
Relationship between large-hole drilling rates and compressive strength of NTS rock types, 14:47896 (RA;US)
Shock vaporization and melting of saturated tuff, 14:47889 (RA;US)
The effect of strain paths calculated for spherically symmetric explosions on measured damage in tuff, 14:47888 (RA;US)
TUMORS
See NEOPLASMS
TUNGSTATES
Studies of supported hydrodesulfurization catalysts: Progress report for period January 1, 1989–December 31, 1989, 14:47484 (R;US)
TUNGSTEN
Atomic displacement distribu< on during ion irradiation, 14:48512 (RA;SU;In Russian)
Creep behavior of tungsten fiber reinforced niobium metal matrix composites, 14:47351 (R;US)
Studies of supported hydrodesulfurization catalysts: Progress report for period January 1, 1989–December 31, 1989, 14:47484 (R;US)
The HEL [Hugoniot Elastic Limit] and rate-dependent yield behavior, 14:47370 (R;US)
The interface in tungsten fiber reinforced niobium metal-matrix composites, 14:47421 (R;US)
Thermophysical investigations of tungsten at high temperatures and pressures, 14:47355 (RA;AT;In German)
TUNGSTEN 184 TARGET
Nuclear-target effects in J/psi production in anti p and π^- interactions, 14:48440 (J;NL)
TUNGSTEN BASE ALLOYS
Recrystallization and respheroidization of tungsten grains in a tungsten-heavy alloy. Final report, 14:47328 (R;US)
TUNGSTEN ISOTOPES
[Collective properties of light tungsten and osmium nuclei]: Foreign trip report, July 24, 1988–July 29, 1988, 14:48480 (R;US)
TUNGSTEN OXIDES
Absorption jump mechanism of EPR in WO_3, MoO_3 compounds of heteropolyanion type, 14:48508 (RA;SU;In Russian)
TUNGSTOPHOSPHATES
Different-ligand complexes of some d-metals with monovacant heteropolyanions, 14:47523 (RA;SU;In Russian)
TUNNEL DIODES
Wigner-function modeling of resonant tunneling diodes with high peak-to-valley ratios, 14:47762 (R;US)
TURBINE BLADES
Role of the turbulent Prandtl number in turbine blade heat transfer prediction, 14:47755 (RA;US)
Structural analysis applications, 14:47775 (RA;US)
TURBULENT FLOW
Molecular mixing and chemical reactions in turbulent shear layers, 14:47587 (BA;US)
TWO-BODY PROBLEM
Electron-positron system at short distances, 14:48395 (R;XA)
TWO-PHASE FLOW
Stability of numerical solutions for stratified two-phase flow, 14:47751 (R;JP)
2-PROPANOL
See PROPANOLS

U

UCLLL
See LAWRENCE LIVERMORE LABORATORY
UHF RADIATION (01-100 GHZ)
See RADIOWAVE RADIATION
UHF RADIATION (100-1000 MHZ)
See RADIOWAVE RADIATION
UHF RADIATION (LOWER RANGE)
See RADIOWAVE RADIATION
UHF RADIATION (UPPER RANGE)
See RADIOWAVE RADIATION
ULTRAHIGH FREQUENCY RADIATION (01-100 GHZ)
See RADIOWAVE RADIATION
ULTRAHIGH FREQUENCY RADIATION (100-1000 MHZ)
See RADIOWAVE RADIATION
ULTRAHIGH FREQUENCY RADIATION (LOWER RANGE)
See RADIOWAVE RADIATION
ULTRAHIGH FREQUENCY RADIATION (UPPER RANGE)
See RADIOWAVE RADIATION

UNCERTAINTY
See DATA COVARIANCES
UNDERGROUND EXPLOSIONS
Blast Effects
Predicting the response of shock-conditioned tuff from Rainier Mesa using laboratory tests, 14:47887 (RA;US)
The effect of strain paths calculated for spherically symmetric explosions on measured damage in tuff, 14:47888 (RA;US)
Cavities
CORNUCOPIA cavity pressure measurement, 14:47900 (RA;US)
Development of centrifuge modeling for evaluating the mechanisms of collapse of underground opening, 14:47911 (RA;US)
Fickian filtering of cavity gases rising through a fractured permeable overburden, 14:47905 (RA;US)
Fluid dynamics of a pressure measuring system for underground explosive tests, 14:47899 (RA;US)
Photogrammetric method for determining sink volumes at the Nevada Test Site, 14:47913 (RA;US)
Trends in cavity collapse data, 14:47912 (RA;US)
Containment
Junior Jade events - An investigation of decoupling phenomenology, 14:47873 (RA;US)
Fracture Mechanics
Junior Jade events - An investigation of decoupling phenomenology, 14:47873 (RA;US)
Gamma-Gamma Logging
Idealized proximity response of the DBS, 14:47890 (RA;US)
Hydraulic Fracturing
Recent developments in hydrofracture calculations related to containment, 14:47874 (RA;US)
Similarity analysis of condensing flow in a fluid driven fracture, 14:47875 (RA;US)
Hydrodynamics
A detailed calculation of the collapse of the Misty Rain extension, 14:47870 (RA;US)
Containment analyses for the Mission Ghost cavity event, 14:47871 (RA;US)
Overburden
Estimation of the bulk diffusivity of chimneys using post-shot holes, 14:47904 (RA;US)
Pressure Measurement
Stress measurements with the sea Calip gauge, 14:47882 (RA;US)
Radioactive Effluents
Dispersion of contaminant during oscillatory gas-motions driven by atmospheric pressure variations, 14:47906 (RA;US)
Radionuclide Migration
Breathing on the Mesa, 14:47903 (RA;US)
Geologic and hydrologic investigations at the ALEMAN (U3KZ) site, and other sites in Yucca Flat, the Nevada Test Site, 14:47909 (RA;US)
Research Programs
Proceedings of the DOE/LLNL symposium on Explosion-Source Phenomenology, 14:47915 (R;US)
Residual Stresses
Effects of late time creep and cavity depressurization on the residual stress field, 14:47879 (RA;US)
The effect of pore fluid diffusion in grout spheres, 14:47883 (RA;US)
Shock Waves
Shock vaporization and melting of saturated tuff, 14:47889 (RA;US)
Stemming Materials
Post-failure strength of gypsum silica-sand aggregate stemming material, 14:47885 (RA;US)
Stemming column phenomenology, 14:47884 (RA;US)
Stress Analysis
Development for centrifuge modeling of buried explosions, 14:47910 (RA;US)
Multi-component stress history measurements and analysis, 14:47880 (RA;US)
Preliminary surface ground motion calculations with the SHALE code, 14:47877 (RA;US)
Theoretical and experimental analyses of in-situ gauge inclusion effects, 14:47881 (RA;US)
UNDERGROUND FACILITIES
Kernville ammonia system, 14:47914 (R;US)
UNDERGROUND MINING
Causes and control of coal mine bumps, 14:46888 (R;US)
Fires in workings with different dips, and consequences to be drawn for the ventilation systems. Final report, 14:46886 (R;DE;In German)
UNDERGROUND STORAGE
Fate and transport of petroleum released from leaking underground-storage tanks in areas of karst topography. Technical report, 14:46900 (R;US)
Fiscal year 1988 measurable environmental results initiatives: Underground storage-tank impacts on ground water. Technical report, 14:48035 (R;US)
UNDERWATER VEHICLES
See SUBMARINES
UNIFIED GAUGE MODELS
Renormalized fermion propagator in hot gauge theories, 14:48421 (J;NL)
Spontaneous parity breaking by quantum corrections, 14:48328 (RA;PL)
UNION OF SOVIET SOCIALIST REPUBLICS
See USSR
UNITED KINGDOM
Camborne geothermal energy project 2C-7 resource evaluation. V. 3. Gravity and thermal modelling, 14:47055 (R;GB)
Scottish Universities Research and Reactor Centre annual report 1987-1988, 14:47013 (R;GB)
UNITED STATES OF AMERICA
See USA
UNIVERSITIES
See EDUCATIONAL FACILITIES
UNIVERSITY OF MISSOURI/COLUMBIA RESEARCH REACTOR
See MURR REACTOR
UPSILON-10000 RESONANCES
See UPSILON-10023 MESONS
UPSILON-10023 MESONS
Hadron production and search for new particles at DESY, 14:48305 (RA;PL)
URANIUM
Characterization of sediment in a leaching trench RCRA (Resource Conservation and Recovery Act) site, 14:46990 (RA;US)
Relationship between kidney burden and radiation dose from chronic ingestion of U: Implications for radiation standards for the public, 14:48139 (J;US)
Search for crystal-catalyzed fusion reactions, 14:48674 (RA;AT;In German)
Ultrapure materials for alpha particle-sensitive applications, 14:47555 (J;US)
Uranium industry annual, 1988, 14:46925 (R;US)
URANIUM 233
Actual experience in burnup determination of mixed oxide fuel, 14:47477 (RA;XA)
URANIUM 235
Fission-product-decay characteristics. Master's thesis, 14:48463 (R;US)
URANIUM 238
Relationship between kidney burden and radiation dose from chronic ingestion of U: Implications for radiation standards for the public, 14:48139 (J;US)
URANIUM ALLOYS
Calorimetric and magnetic properties in uranium -intermetallic compounds, 14:47353 (RA;AT;In German)
URANIUM COMPLEXES
Spectroscopic study of U(5) coordination compounds, 14:47551 (RA;SU;In Russian)
URANIUM COMPOUNDS
Electron spectroscopy of the gas phase of uranium (6) alkoxides, 14:47552 (RA;SU;In Russian)

Observation of long-range ferromagnetic order in the heavy-fermion compuound $URu_{1.2}Re_{0.8}Si_2$ by neutron scattering, 14:47330 (R;US)

URANIUM HEXAFLUORIDE
Nuclear closed-cycle gaseous heat engine concept, 14:47101 (R;US)
REIMIEP 1987: an interlaboratory U-235 enrichment determination by gamma measurement on solid UF6 sample, 14:46927 (R;IT)

URANIUM MINES
Design of a disposal cell for uranium mill tailings at Collin's Ranch, Oregon: A case study in informal dynamic optimization, 14:46947 (RA;US)
Eenie, meenie, minie, moe, where do Monument Valley tailings go?, 14:46948 (RA;US)

URANYL COMPLEXES
^1H, ^{19}F, NMR study of crystal dynamics of ammonium and rubidium pentafluorouranylates, 14:47549 (RA;SU;In Russian)
Crystal structure and spectroscopic properties of tetraphenylarsonium tetrachlorouranylate, 14:47550 (RA;SU;In Russian)

URBAN AREAS
Combined sewer overflow: A management study. Technical report, 14:48061 (R;US)
Development of the Regional Oxidant Model version 2.1. Interim report, January 1988-April 1989, 14:47954 (R;US)
Methods for municipal traffic safety work - improvement of traffic environment. A literature survey, 14:47280 (R;FI;In Finnish)

UROGENITAL SYSTEM DISEASES
Evaluation of research on cadmium inhalation-exposure estimate and their significance for kidney and liver cadmium burden, 14:48149 (R;US)

US DOD
Statement on superconductivity, 14:47714 (R;US)

US DOE
Demand-side management federal program directory, 14:47236 (R;US)
Introductory remarks, 14:46796 (RA;US)
Program distribution for unclassified scientific and technical reports: Instructions and category scope notes: Revision 75, 14:48741 (R;US)
The Department of Energy response to TMI [Three Mile Island], 14:47188 (J;US)

US EPA
An approach to remedial action decisions on sites which are marginally contaminated with Radium-226, 14:47004 (R;US)
Central radon data base and digitized bedrock map of US EPA (Environmental Protection Agency) Region 1. Technical report, 14:47964 (R;US)
EPA's (Environmental Protection Agency) role in non-hazardous solid-waste management on Indian land: Issues and options. Technical report, 14:47231 (R;US)
Integrated environmental management: A need for change. Technical report, 14:47227 (R;US)
Wetlands and water quality: EPA's (Environmental Protection Agency's) research and monitoring implementation plan for the years 1989-1994, 14:48062 (R;US)

US NRC
The Three Mile Island Unit 2 accident and its impact on the NRC, 14:47186 (J;US)

US ORGANIZATIONS
Implementation and management of waste minimization programs at federal facilities, 14:47213 (RA;US)

US WATER POLLUTION CONTROL ACT
See CLEAN WATER ACT

USA
Free trade and energy, 14:47212 (R;CA;In English and French)
Free trade on the prairies. The implications of the Canada-U.S. trade pact for the three prairie provinces, 14:47251 (R;CA)
[Fluidized bed combustion of high-ash Indian coals]: Foreign trip report, January 5, 1988–March 16, 1988, 14:46881 (R;US)

USSR
Soviet concepts of ballistic missile defense. Master's thesis, 14:47319 (R;US)

UTERINE CERVIX CARCINOMA
See UROGENITAL SYSTEM DISEASES

V

VACUUM FURNACES
Vacuum heat training furnace: Final technical report, 14:47717 (R;US)

VACUUM SYSTEMS
Refurbishment of the vacuum system of the Brookhaven Alternating Gradient Synchrotron, 14:47801 (R;US)

VALENCE ELECTRONS
See ELECTRONS

VALVES
Aging and service wear of electric motor-operated valves used in engineered safety-feature systems of nuclear power plants: Aging assessments and monitoring method evaluations, 14:47147 (R;US)

VAN ALLEN BELTS
See RADIATION BELTS

VANADATES
ESR in hydrated lithium and sodium dodecavanadates with vanadium mixed oxidation, 14:47491 (RA;SU;In Russian)

VANADIUM
Extended fine structure in appearance potential spectroscopy as a probe of solid surfaces, 14:47339 (RA;US)
Polishing methods for metallic and ceramic transmission electron microscopy specimens: Revision 1, 14:47329 (R;US)

VANADIUM ALLOYS
The HEL [Hugoniot Elastic Limit] and rate-dependent yield behavior, 14:47370 (R;US)

VANADIUM BASE ALLOYS
Tensile behavior of helium-implanted and neutron-irradiated V-15 Cr-5 Ti, 14:48697 (J;US)

VANADIUM COMPLEXES
Application of XPS, UV- and IR-spectroscopy to structure study of V(5) complexes in surface phase at $SiO_2/VO_{2.5}$ interface and catalysts on their basis, 14:47524 (RA;SU;In Russian)
ESR of the first members of copper and vanadyl metal chelates of 2-acetylbenzimidazole thiosemicarbazones, 14:47488 (RA;SU;In Russian)
ESR study of aquahumate complexes of iron (3), copper (2), manganese (2), vanadium (4), and chromium (3), 14:47494 (RA;SU;In Russian)
ESR study of fast solvate-exchange reactions in oxovanadium (4) β-diketonate solutions, 14:47497 (RA;SU;In Russian)
Spectroscopic properties of heterovalent complexes of titanium, vanadium, iron, copper, 14:47521 (RA;SU;In Russian)
Synthesis and investigation of vanadyl (2) coordination compounds with aromatic amino acids, 14:47489 (RA;SU;In Russian)
Vanadium complexing with thiooxalates, 14:47495 (RA;SU;In Russian)

VANADIUM COMPOUNDS
Rapid technique of vanadium (4), determination in the presence of vanadium (5), 14:47476 (RA;SU;In Russian)

VANADIUM MINERALS
See MINERALS

VAPOR CONDENSATION
Kinetic boundary layer on a sphere and the growth of droplets, 14:48262 (RA;AT;In German)

VASCULAR DISEASES
Stereotactic heavy-charged-particle Bragg peak radiosurgery for the treatment of intracranial arteriovenous malformations in childhood and adolescence, 14:48112 (J;US)

VECTOR MESONS
Effective Lagrangian describing new vector mesons in a strong interacting Higgs sector, 14:48329 (RA;PL)
Effective QCD chiral Lagrangian for pions and vector mesons and hidden local symmetry, 14:48326 (R;XA)
Higher vector mesons in nucleon form factors, 14:48342 (RA;PL)

VEGETATION
See PLANTS

VEHICLES
Dedicated low-pressure natural gas-fueled vehicle baseline assessment. Task 3 topical report on light-duty vehicles. Topical report, January 1987-January 1989, 14:47318 (R;US)
Land vehicle teleoperation under conditions of reduced video resolution, 14:47724 (R;US)
MOBILE4 emission factor model: source code (one version mixed case, one version upper case), input files for example runs, and high-altitude area I/M credits (for microcomputers). Model, 14:47316 (R;US)
VENTILATION DUCTS
See DUCTS
VENTILATION SYSTEMS
Performance of ventilation systems in residential buildings, 14:47275 (R;FI;In Finnish)
VERIFICATION
A methodology for identifying, evaluating, and controlling the incremental risk of inadvertent sensitive information disclosure during on-site verification inspections at US facilities, 14:47322 (R;US)
VERY HIGH FREQUENCY RADIATION
See RADIOWAVE RADIATION
VESSELS (CHEMICAL REACTIONS)
See CHEMICAL REACTORS
VESSELS (PRESSURE)
See PRESSURE VESSELS
VESSELS (REACTOR)
See REACTOR VESSELS
VETERINARY MEDICINE
Staircase-shaped test phantom for control of image quality in veterinary medicine, 14:48105 (RA;AT;In German)
VHF RADIATION
See RADIOWAVE RADIATION
VINOFLEX
See POLYVINYLS
VINYL CHLORIDE
Flame-jet ignition of large fuel-air clouds, 14:47655 (BA;US)
VINYL RADICALS
Reactions of vinyl and phenyl radicals with ethyne, ethene and benzene, 14:47630 (BA;US)
VISCOUS FLOW
Analytical and numerical studies in flow development: Progress report, 1 July 1988 to Present, 14:48284 (R;US)
VOLATILE MATTER
A combined oxygen/bubble probe for the study of fluidized bed combustion of volatiles, 14:46871 (BA;US)
Modified purge-and-trap/gas-chromatography method for analysis of volatile halocarbons in microbiological degradation studies (journal version), 14:48031 (R;US)
Walk-through survey report, Gulfstream American Corporation (formerly Grumman-American Aviation Corp.) Savannah, Georgia, 14:47956 (R;US)
VOLCANOES
3-dimensional numerical simulation of the atmospheric injection of aerosols by a hypothetical basaltic fissure eruption, 14:48209 (RA;US)
Iridium emissions from Hawaiian volcanoes, 14:48196 (RA;US)
VOLTAIC CELLS
See ELECTRIC BATTERIES
VOMITING
Influence of pyridostigmine on the antiemetic effect of domperidone in irradiated macaques, 14:48137 (RA;FR;In French)
VORTEX FLOW
Modelling of confined swirling flows, 14:47777 (R;FI)

W

W MINUS BOSONS
The electric dipole moment of the W boson and the radiation amplitude zero: [Revised], 14:48325 (R;US)
WALL EFFECTS
Nonlinear simulations of wall locking and tokamak disruptions, 14:48630 (RA;AU)
WALLS
Contaminated concrete scabbling at the Shippingport Station Decommissioning Project, 14:47000 (R;US)
Thermal behaviour of transparent layers of insulation on building facades - comparison of measurement and calculation. Interim report, 14:47268 (R;DE;In German)
WASHOUT
Regional analysis of wet deposition for effects research. Project report, 14:47936 (R;US)
WASTE CHEMICALS
See CHEMICAL WASTES
WASTE DISPOSAL
Air Pollution
Superfund Record of Decision (EPA Region 3): Palmerton Zinc Pile, Pennsylvania (second remedial action), September 1988, 14:47970 (R;US)
By-Products
Technologies and costs for the treatment and disposal of waste byproducts from water treatments for the removal of inorganic and radioactive contaminants (revised draft), September 1986, 14:48040 (R;US)
Incinerators
Hospital incinerator operator training course. Volume 1. Student handbook. Final report, 14:47948 (R;US)
Hospital incinerator operator training course. Volume 2. Presentation slides. Final report, 14:47949 (R;US)
Land Pollution
Superfund Record of Decision (EPA Region 2): Asbestos Dump, Millington Site, Millington, New Jersey (first remedial action), September 1988, 14:47999 (R;US)
Superfund Record of Decision (EPA Region 2): Ewan Property, Burlington County, New Jersey (first remedial action), September 1988, 14:48004 (R;US)
Superfund Record of Decision (EPA Region 3): Dorney Road Landfill Superfund Site, Lehigh County, Pennsylvania (first remedial action), September 1988, 14:48002 (R;US)
Superfund Record of Decision (EPA Region 3): Drake Chemical Site, Lock Haven, Pennsylvania (third remedial action), September 1988. Final report, 14:48079 (R;US)
Superfund Record of Decision (EPA Region 3): Wildcat Landfill, Kent County, Delaware (first remedial action), June 1988, 14:48003 (R;US)
Superfund Record of Decision (EPA Region 4): Celanese Fibers Operations, Shelby, North Sarolina (first remedial action), March 1988, 14:48078 (R;US)
Superfund Record of Decision (EPA Region 5): Kummer Sanitary Landfill, Beltrami County, Minnesota (second remedial action) September 1988, 14:48006 (R;US)
Superfund Record of Decision (EPA Region 5): Republic Steel Quarry Site, Elyria, Ohio (first remedial action), September 1988. Final report, 14:48075 (R;US)
Superfund Record of Decision (EPA Region 5): Velsicol Chemical Corporation, Marshall, Illinois (first remedial action), September 1988. Final report, 14:48076 (R;US)
Superfund Record of Decision (EPA Region 6): French Limited, Texas (first remedial action), March 1988. Final report, 14:48008 (R;US)
Superfund Record of Decision (EPA Region 9): MGM Brakes site, Cloverdale, California (first remedial action), September 1988. Final report, 14:48054 (R;US)
Superfund Record of Decision (EPA Region 9): South Bay Asbestos Area, California (first remedial action), September 1988. Final report, 14:48011 (R;US)
Regulations
Problems mixed wastes pose in implementing RCRA (Resource Conservation and Recovery Act) requirements, 14:46996 (RA;US)
Remedial Action
Superfund Record of Decision (EPA Region 1): Rose Disposal Pit, Lanesborough, Massachusetts (first remedial action) September 1988. Final report, 14:48005 (R;US)

Sanitary Landfills
- Ox Mountain sanitary landfill: Apanolio Canyon expansion site, San Mateo County, California. Volume 2. Appendix. Final report, 14:47977 (R;US)
- Superfund Record of Decision (EPA Region 1): Landfill and Resource Recovery, Rhode Island (first remedial action), September 1988. Final report, 14:48007 (R;US)
- Superfund Record of Decision (EPA Region 1): Old Springfield Landfill, Vermont (first remedial action), September 1988, 14:48080 (R;US)
- Superfund Record of Decision (EPA Region 9): Operating Industries, Inc. (OII), Monterey Park, California (third remedial action), September 1988, 14:48001 (R;US)

Water
- Superfund Record of Decision (EPA Region 1): Groveland Wells Nos. 1 and 2 Site, Valley site source-control organic operable unit, Groveland, Massachusetts (first remedial action), September 1988, 14:48057 (R;US)

Water Pollution
- Superfund Record of Decision (EPA Region 1): Rose Disposal Pit, Lanesborough, Massachusetts (first remedial action) September 1988. Final report, 14:48005 (R;US)
- Superfund Record of Decision (EPA Region 2): Asbestos Dump, Millington Site, Millington, New Jersey (first remedial action), September 1988, 14:47999 (R;US)
- Superfund Record of Decision (EPA Region 2): Ewan Property, Burlington County, New Jersey (first remedial action), September 1988, 14:48004 (R;US)
- Superfund Record of Decision (EPA Region 3): Dorney Road Landfill Superfund Site, Lehigh County, Pennsylvania (first remedial action), September 1988, 14:48002 (R;US)
- Superfund Record of Decision (EPA Region 3): Drake Chemical Site, Lock Haven, Pennsylvania (third remedial action), September 1988. Final report, 14:48079 (R;US)
- Superfund Record of Decision (EPA Region 3): Palmerton Zinc Pile, Pennsylvania (second remedial action), September 1988, 14:47970 (R;US)
- Superfund Record of Decision (EPA Region 3): Wildcat Landfill, Kent County, Delaware (first remedial action), June 1988, 14:48003 (R;US)
- Superfund Record of Decision (EPA Region 4): Celanese Fibers Operations, Shelby, North Sarolina (first remedial action), March 1988, 14:48078 (R;US)
- Superfund Record of Decision (EPA Region 5): Kummer Sanitary Landfill, Beltrami County, Minnesota (second remedial action) September 1988, 14:48006 (R;US)
- Superfund Record of Decision (EPA Region 5): Republic Steel Quarry Site, Elyria, Ohio (first remedial action), September 1988. Final report, 14:48075 (R;US)
- Superfund Record of Decision (EPA Region 5): Velsicol Chemical Corporation, Marshall, Illinois (first remedial action), September 1988. Final report, 14:48076 (R;US)
- Superfund Record of Decision (EPA Region 6): French Limited, Texas (first remedial action), March 1988. Final report, 14:48008 (R;US)
- Superfund Record of Decision (EPA Region 7): Shenandoah Stables, Missouri (first remedial action), July 1988, 14:48010 (R;US)
- Superfund Record of Decision (EPA Region 9): MGM Brakes site, Cloverdale, California (first remedial action), September 1988. Final report, 14:48054 (R;US)
- Superfund Record of Decision (EPA Region 9): South Bay Asbestos Area, California (first remedial action), September 1988. Final report, 14:48011 (R;US)
- Superfund Record of Decision: (EPR Region 6): Curley Pit Site, ground-water operable unit, Crittenden County, Arkansas (second remedial action), September 1988. Final report, 14:48055 (R;US)

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- Engineering and economic analysis of containment area/wetlands disposal options in New York harbor. Final report, 14:48018 (R;US)
- Sludge Incineration Model (SIM) (for microcomputers). Model-Simulation, 14:47298 (R;US)

WASTE MANAGEMENT
- Best demonstrated available technology (BDAT) background document for K046 nonreactive subcategory. Final report, 14:47291 (R;US)
- Best demonstrated available technology (BDAT) background document for K101 and K102: Low arsenic subcategory. Final report, 14:47292 (R;US)
- Complex environmental requirements compel logical approach: The CERCLA Comprehensive Environmental Response, Compensation, and Liability Act) framework at Fernald, 14:47222 (RA;US)
- Critique of several regulatory analyses regarding solvent wastes. Technical report, 14:48000 (R;US)
- Multi-media compliance audit procedures, 1989. Final report, 14:47232 (R;US)
- RCRA (Resource Conservation and Recovery Act) inspection manual. Final report, 14:47293 (R;US)
- Study and assessment of eight yard waste-composting programs across the United States. Technical report, 14:47299 (R;US)
- University programs in waste management research, education, and training, 14:46989 (RA;US)
- Water-Waste-Soil Project: 1st Report on the status colloquium, 14:48021 (R;DE;In German)

WASTE PRODUCT UTILIZATION
- Silicate bonded ceramics of laterites, 14:47389 (R;XA)

WASTE SOLUTIONS
- *See* LIQUID WASTES

WASTE WATER
- Best demonstrated available technology (BDAT) background document for K103 and K104. Final report, 14:47290 (R;US)
- Composting of surface peat, waste water sludge and bark, the properties and suitability of substietes for growing media for landscaping, 14:47038 (R;FI;In Finnish)
- Guidelines and requirements for applying for grants from the Indian set-aside program, 14:48073 (R;US)
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WASTES
- A comprehensive program to develop correlations for the physical properties of kraft black liquors, 14:47283 (R;US)

WATER
- Experiment on removal of radon in water by using of de-airing membrane, 14:48048 (RA;JP;In Japanese)
- Fundamental studies in charge separation at interfaces in relation to water photolysis: Progress report, January 15, 1987–June 25, 1989, 14:47483 (R;US)
- Measurements of absolute rate coefficients for the reactions of CN radicals with H_2O, H_2, and CO_2 in the temperature range $295\ K \leq T \leq 1027\ K$, 14:47637 (BA;US)
- Nonlinear effects in water waves, 14:48544 (R;XA)
- Superfund Record of Decision (EPA Region 1): Groveland Wells Nos. 1 and 2 Site, Valley site source-control organic operable unit, Groveland, Massachusetts (first remedial action), September 1988, 14:48057 (R;US)

WATER COOLANT
- *See* WATER

WATER MODERATOR
- *See* WATER

WATER POLLUTION

Biodegradation

Modified purge-and-trap/gas-chromatography method for analysis of volatile halocarbons in microbiological degradation studies (journal version), 14:48031 (R;US)

Chemical Analysis

Evaluation of high-resolution gas for the determination of 2, 3, 7, 8-TCDD in soil, sediment and water (journal version), 14:47479 (R;US)

Data Analysis

Extent and trend of nitrate contamination in Region III: The Coastal Plain and Piedmont Province. Technical report, 14:48034 (R;US)

Environmental Impacts

Ambient water-quality criteria for ammonia (salt water)-1989, 14:48074 (R;US)

Geochemistry

[Water-rock interaction]: Foreign trip report, August 1–15, 1989, 14:48024 (R;US)

Measuring Methods

Utility of surface-floating Vhironomidae pupal exuviae in assessing the impact of PCBs on two stream communities. Technical report, 14:48036 (R;US)

Mitigation

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Monitoring

Fiscal year 1988 measurable environmental results initiatives: Underground storage-tank impacts on ground water. Technical report, 14:48035 (R;US)

Remedial Action

Superfund Record of Decision (EPA Region 1): Landfill and Resource Recovery, Rhode Island (first remedial action), September 1988. Final report, 14:48007 (R;US)

Superfund Record of Decision (EPA Region 1): Old Springfield Landfill, Vermont (first remedial action), September 1988, 14:48080 (R;US)

Superfund Record of Decision (EPA Region 1): Rose Disposal Pit, Lanesborough, Massachusetts (first remedial action) September 1988. Final report, 14:48005 (R;US)

Superfund Record of Decision (EPA Region 2): Asbestos Dump, Millington Site, Millington, New Jersey (first remedial action), September 1988, 14:47999 (R;US)

Superfund Record of Decision (EPA Region 2): Ewan Property, Burlington County, New Jersey (first remedial action), September 1988, 14:48004 (R;US)

Superfund Record of Decision (EPA Region 3): Dorney Road Landfill Superfund Site, Lehigh County, Pennsylvania (first remedial action), September 1988, 14:48002 (R;US)

Superfund Record of Decision (EPA Region 3): Drake Chemical Site, Lock Haven, Pennsylvania (third remedial action), September 1988. Final report, 14:48079 (R;US)

Superfund Record of Decision (EPA Region 3): Palmerton Zinc Pile, Pennsylvania (second remedial action), September 1988, 14:47970 (R;US)

Superfund Record of Decision (EPA Region 3): Wildcat Landfill, Kent County, Delaware (first remedial action), June 1988, 14:48003 (R;US)

Superfund Record of Decision (EPA Region 4): Celanese Fibers Operations, Shelby, North Sarolina (first remedial action), March 1988, 14:48078 (R;US)

Superfund Record of Decision (EPA Region 4): Flowood, Rankin County, Mississippi (first remedial action), September 1988. Final report, 14:48077 (R;US)

Superfund Record of Decision (EPA Region 5): Kummer Sanitary Landfill, Beltrami County, Minnesota (second remedial action) September 1988, 14:48006 (R;US)

Superfund Record of Decision (EPA Region 5): Republic Steel Quarry Site, Elyria, Ohio (first remedial action), September 1988. Final report, 14:48075 (R;US)

Superfund Record of Decision (EPA Region 5): Velsicol Chemical Corporation, Marshall, Illinois (first remedial action), September 1988. Final report, 14:48076 (R;US)

Superfund Record of Decision (EPA Region 6): French Limited, Texas (first remedial action), March 1988. Final report, 14:48008 (R;US)

Superfund Record of Decision (EPA Region 6): Sol Lynn/Industrial Transformers, Texas (first remedial action), September 1988. Final report, 14:48009 (R;US)

Superfund Record of Decision (EPA Region 7): Shenandoah Stables, Missouri (first remedial action), July 1988, 14:48010 (R;US)

Superfund Record of Decision (EPA Region 9): MGM Brakes site, Cloverdale, California (first remedial action), September 1988. Final report, 14:48054 (R;US)

Superfund Record of Decision (EPA Region 9): Operating Industries, Inc. (OII), Monterey Park, California (third remedial action), September 1988, 14:48001 (R;US)

Superfund Record of Decision (EPA Region 9): South Bay Asbestos Area, California (first remedial action), September 1988. Final report, 14:48011 (R;US)

Superfund Record of Decision: (EPR Region 6): Curley Pit Site, ground-water operable unit, Crittenden County, Arkansas (second remedial action), September 1988. Final report, 14:48055 (R;US)

Samplers

Generalized ground-water sampling device matrix (journal version), 14:48032 (R;US)

WATER POLLUTION ABATEMENT

Water-pollution abatement expenditures in the Wisconsin paper industry. Technical report, 14:48037 (R;US)

WATER POLLUTION CONTROL

Biodegradation of trichloroethylene and biomanipulation of aquifers. Technical report (Final), 14:48030 (R;US)

Combined sewer overflow: A management study. Technical report, 14:48061 (R;US)

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Cost supplement to the removal of cadmium from potable-water supplies (first draft), February 1987, 14:48042 (R;US)

Engineering and economic analysis of containment area/wetlands disposal options in New York harbor. Final report, 14:48018 (R;US)

Sludge Incineration Model (SIM) (for microcomputers). Model-Simulation, 14:47298 (R;US)

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WATER POLLUTION MONITORS

Approaches to risk training: An evaluation of EPA (Environmental Protection Agency) risk training materials. Technical report, 14:47229 (R;US)

WATER QUALITY

Chesapeake bay basinwide toxics reduction strategy: an agreement commitment report from the Chesapeake Executive Council. Final report, 14:48052 (R;US)

Drinking-Water Criteria Document for Asbestos (final draft), March 1985, 14:48064 (R;US)

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Drinking-Water Criteria Document for selenium (final draft), December 1986, 14:48068 (R;US)

Estimated low-range costs for the removal of inorganics, radionuclides, and corrosion-related contaminants from potable water supplies (draft), January 1987, 14:48039 (R;US)
Federalism and the surface-water program. Technical report, 14:48059 (R;US)
Information collection request for proposed National Primary Drinking Water Regulations for synthetic organic chemicals (draft), April 1989, 14:48072 (R;US)
Information-collection request for: National Primary Drinking Water Regulations for inorganic chemicals. Phase 2, March 1989, 14:48071 (R;US)
Regulatory impact analysis of proposed National Primary Drinking Water Regulations for synthetic organic chemicals. Phase 2, April 1989, 14:48070 (R;US)
Regulatory impact analysis: Benefits and costs of proposed National Primary Drinking Water Regulations for inorganic chemicals. Phase 2, March 1989, 14:48069 (R;US)
Technologies and costs for the treatment and disposal of waste byproducts from water treatments for the removal of inorganic and radioactive contaminants (revised draft), September 1986, 14:48040 (R;US)
Wetlands and water quality: EPA's (Environmental Protection Agency's) research and monitoring implementation plan for the years 1989-1994, 14:48062 (R;US)
[Review three interim reports on numerical modeling, tracer study, and monitoring design]: Foreign trip report, January 18–27, 1989, 14:46971 (R;US)

WATER SOLUTIONS
See AQUEOUS SOLUTIONS

WATER TREATMENT
Cost and performance of membranes for organic control in small systems: Flagler Beach and Punta Gorda, Florida. Final report, 1 June 1986-28 February 1989, 14:48038 (R;US)
Estimated low-range costs for the removal of inorganics, radionuclides, and corrosion-related contaminants from potable water supplies (draft), January 1987, 14:48039 (R;US)
Feasibility of adding TCE [trichloroethylene] still area and Northeast area plumes to ultraviolet radiation, ozone, hydrogen peroxide groundwater treatment plant, Department of Energy Kansas City Plant, 14:48025 (R;US)
Improving state outreach to small communities. Technical report, 14:48060 (R;US)
Information collection request for proposed National Primary Drinking Water Regulations for synthetic organic chemicals (draft), April 1989, 14:48072 (R;US)
Information-collection request for: National Primary Drinking Water Regulations for inorganic chemicals. Phase 2, March 1989, 14:48071 (R;US)
Regulatory impact analysis of proposed National Primary Drinking Water Regulations for synthetic organic chemicals. Phase 2, April 1989, 14:48070 (R;US)
Regulatory impact analysis: Benefits and costs of proposed National Primary Drinking Water Regulations for inorganic chemicals. Phase 2, March 1989, 14:48069 (R;US)
Technologies and costs for the treatment and disposal of waste byproducts from water treatments for the removal of inorganic and radioactive contaminants (revised draft), September 1986, 14:48040 (R;US)

WATER TREATMENT PLANTS
Guidelines and requirements for applying for grants from the Indian set-aside program, 14:48073 (R;US)
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Sewage-treatment costs and economics. July 1987-July 1989 (Citations from the NTIS data base). Report for July 1988-July 1989, 14:47300 (R;US)

WATER VAPOR
Laser photolysis shock tube for combustion kinetics studies, 14:47538 (BA;US)
Stopping power of water vapor for deuterium ions, 14:48264 (RA;AT;In German)

WATER WELLS
Hanford wells, 14:48046 (R;US)
High fluid levels in drill holes, Yucca Flat, Nevada Test Site, 14:47907 (RA;US)
Hydrogeology of Melton Valley determined from hydraulic head measuring station data, 14:48027 (R;US)

WATERBORNE PARTICLES
See PARTICULATES

WATT-HOUR METERS
See POWER METERS

WAVE EQUATIONS
$E=(h/2\pi)\omega$, 14:48547 (R;XA)
Hidden regularity for a strongly nonlinear wave equation, 14:48572 (R;BR)

WAVE FUNCTIONS
Measurement of Berry's topological phase for non-cyclic evolution, 14:48566 (RA;AT;In German)

WAVE PACKETS
Strong quantum-mechanical instability of orbital motion of a macroscopic body in a gravitational field, 14:48570 (RA;SU;In Russian)

WAVE PROPAGATION
Alfven wave heating in the TORTUS tokamak, 14:48640 (RA;AU)
Nonlinear effects in water waves, 14:48544 (R;XA)

WAZ 16
See NICKEL BASE ALLOYS

WEATHER
A desk-top computer forecast for emergency response planning, 14:47919 (R;US)

WEATHERING
Materials Aerometric data base for use in developing materials damage functions, 14:47967 (R;US)
Paint coatings: Controlled field and chamber experiments, 14:47947 (R;US)

WECS
See WIND TURBINES

WEINBERG LEPTON MODEL
Standard electroweak model and beyond: a review, 14:48340 (RA;PL)

WEINBERG MODEL
See WEINBERG LEPTON MODEL

WELL LOGGING EQUIPMENT
Idealized proximity response of the DBS, 14:47890 (RA;US)
Prototype Borehole Directional Radar System, 14:47852 (R;US)

WESTERN REGION
See FEDERAL REGION IX

WET DEPOSITION
See WASHOUT

WETLANDS
Engineering and economic analysis of containment area/wetlands disposal options in New York harbor. Final report, 14:48018 (R;US)
Wetlands and waste-water management: Questions, answers, advice, and guidance. Technical report, 14:48063 (R;US)
Wetlands and water quality: EPA's (Environmental Protection Agency's) research and monitoring implementation plan for the years 1989-1994, 14:48062 (R;US)

WHOLE-BODY IRRADIATION
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WIGNER COEFFICIENTS
Wigner-function modeling of resonant tunneling diodes with high peak-to-valley ratios, 14:47762 (R;US)

WIND
Error analysis in the determination of the power performance of wind energy conversion systems, 14:47068 (R;NL)

WIND ENERGY CONVERSION SYSTEMS
See WIND TURBINES

WIND GENERATORS
See WIND TURBINES

WIND POWER PLANTS
Development of a wind energy system for generating electrical energy in developing countries in the power range from 5 to 8 kW. Final report, 14:47071 (R;DE;In German)

Measurements on the AEOLUS 11 wind power plant and comparison with rated loads, 14:47069 (R;DE;In German)
WIND TURBINES
BERWIAN: Development, construction and operation of a new type of wind power plant with vortex screw focusser (phase 1), 14:47072 (R;DE;In German)
Error analysis in the determination of the power performance of wind energy conversion systems, 14:47068 (R;NL)
Recommendations for a European wind turbine standard on performance determination, 14:47067 (R;NL)
User's guide for a personal computer model of turbulence at a wind turbine rotor, 14:47073 (R;US)
Utilization of small wind energy converters in the Federal Republic of Germany. Final report, 14:47070 (R;DE;In German)
WINDOWS
Methodology of window thermal performance assessment techniques in the US and the UK, 14:47266 (R;GB)
WISCONSIN
Water-pollution abatement expenditures in the Wisconsin paper industry. Technical report, 14:48037 (R;US)
WOLFRAM
See TUNGSTEN
WOOD
Combustion efficiency, radiation, CO and soot yield from a variety of gaseous, liquid, and solid fueled buoyant diffusion flames, 14:46902 (BA;US)
Continuum-mechanical derivation of the conservation equations for the pyrolysis and combustion of wood. Research report, 14:47029 (R;FI)
WOOD ALCOHOL
See METHANOL
WOOD FUELS
Research and development in wood energy harvesting and handling, 14:47034 (RA;CA)
WOOD WASTES
Biomass energy for Mississippi, 14:47030 (R;US)
Research and development in wood energy harvesting and handling, 14:47034 (RA;CA)
WORKERS
See PERSONNEL
WORKING (MATERIALS)
See MATERIALS WORKING

X

X-2830 RESONANCES
See MESONS
X-RASERS
See X-RAY LASERS
X-RAY LASERS
Summaries of papers presented at the short-wavelength coherent radiation: Generation and applications topical meeting held in Cape Cod, Massachusetts on September 26-29, 1988. Final report, 9 March 1988-1 March 1989, 14:47738 (R;US)
X-RAY SOURCES
Energy in physics, war and peace, 14:47016 (B;US)
Workshop on cooling of x-ray monochromators on high power beamlines, 14:47812 (R;JP)
X-ray lithography sources: A review, 14:47800 (R;US)
X-RAY SPECTRA
Measurement of the ISO series of filtered radiations, 14:47820 (R;GB)
X-RAY SPECTROSCOPY
Extended fine structure in appearance potential spectroscopy as a probe of solid surfaces, 14:47339 (RA;US)
High resolution x-ray spectroscopy using germanium microcalorimeters, 14:47850 (R;US)
XENON
Breathing on the Mesa, 14:47903 (RA;US)
XEROGRAPHY
The materials of xerography: A case study in the interaction of engineering and science, 14:47415 (RA;US)
XUV
See EXTREME ULTRAVIOLET RADIATION
XYLANASE
Microbial solubilization of peat for production of synthetic fuels, 14:46805 (RA;US)
XYLANASES
See XYLANASE

Y

Y-12 PLANT
Technological issues in Y-12 plant RCRA land unit closures, 14:47982 (RA;US)
Waste certification at the Y-12 Plant, 14:46938 (RA;US)
YANG-MILLS THEORY
Critical questions concerning light cone formulation and possible renormalization of Yang-Mills theories, 14:48396 (RA;PL)
YTTERBIUM ALLOYS
Rare earth Moessbauer absorption in $ErPd_2Sn$ and $YbPd_2Sn$, 14:47333 (R;FR)
YTTERBIUM COMPOUNDS
^{170}Yb Moessbauer study of the heavy-electron pnictides YbP, YbAs and YbSb, 14:47332 (R;FR)
ENDOR spectroscopy of admixture ions in crystals of inorganic chlorides, 14:47486 (RA;SU;In Russian)
YTTRIUM
Rutherford-backscattering study of high-temperature oxidation of Y-implanted Fe-24Cr, 14:47384 (J;US)
YTTRIUM ALLOYS
Spin fluctuations and weak itinerant ferromagnetism in $Y(Co_{1-x}Al_x)_2$ $(0{,}00 \leq x \leq 0{,}18)$, 14:47357 (RA;AT;In German)
YTTRIUM ALUMINIUM GARNETS
See ALUMINIUM OXIDES
YTTRIUM COMPOUNDS
YTTRIUM COMPOUNDS
EPR spectra peculiarities of $Y_1Ba_2Cu_3O_{7-x}$ system, 14:48507 (RA;SU;In Russian)
Fundamental and applied studies of explosively fabricated high-temperature superconducting fixtures. Quarterly technical report, 1 September-31 November 1988, 14:47386 (R;US)
Specific heat in mono-crystal YbCo: lambda-like anomalies at 90 and 229K, 14:47402 (R;NO)
X-ray and γ-ray spectroscopy of solids under pressure: Annual technical progress report, October 1988–October 1989, 14:47471 (R;US)
YTTRIUM HYDROXIDES
Utility of cyclodichlorophosphazene as a NaC_5H_5 scavenging reagent: Synthesis of an organoyttrium hydroxide complex and the x-ray crystal structure of the layered compound $((C_5H_5)_2Y(\mu\text{-}OH))_2$ $(C_6H_5C{\equiv}CC_6H_5)$, 14 : 47531(*J*; *US*)
YTTRIUM OXIDES
A fermi liquid electric structure and the nature of the carriers in high-T_c cuprates: A photoemission study, 14:48531 (R;US)
Anomalous ion-channeling behavior across the superconducting transition in high-T_c materials, 14:48497 (R;US)
High-temperature materials compatibility testing of refractory crucible materials: TaC, Y_2O_3, Y_2O_3-coated MgO, and BN, 14:46930 (R;US)
Optical properties of superconducting metal oxide ceramics, 14:47394 (RA;SU;In Russian)
Phonons and charge-transfer excitations in HTS superconductors, 14:48532 (R;US)
[Origins of high-temperature superconductivity in the new copper oxide based ceramic superconductors]: Foreign trip report, July 20, 1988–July 29, 1989, 14:48534 (R;US)
YTTRIUM TUNGSTATES
Correlation studyj of the structure and spectroscopic characteristics of coordination compounds of double tungstates of alkali and rare earth elements, 14:47520 (RA;SU;In Russian)
YUCCA MOUNTAIN
Mineralogy-petrology studies and natural barriers at Yucca Mountain, Nevada, 14:46970 (R;US)

YUKON RIVER
Outer Continental Shelf environmental assessment program. Final reports of principal investigators. Volume 58, 14:46899 (R;US)

Z

Z NEUTRAL BOSONS
On the process $e^+e^- \rightarrow Z^0\nu\nu$-bar near the Z^0 threshold, 14:48350 (RA;SU)

Z PINCH DEVICES (LINEAR)
See LINEAR Z PINCH DEVICES

ZERO POWER REACTORS
Analysis of the VENUS-3 experiments, 14:47105 (R;US)

ZINC
Metals in intimate contact, 14:47336 (RA;US)
Microbial dissolution of toxic metals from coal residues, 14:46839 (RA;US)

ZINC COMPOUNDS
Phase I, Volume I, Program summary and PDU [process development unit] operations: Topical report, October 1987–January 1989, 14:46816 (R;US)

ZINC OXIDES
Model Cu/ZnO catalysts for methanol synthesis: The role of surface structure: Progress report, 14:47025 (R;US)

ZINC PHOSPHATES
Polyelectrolyte-diffused zinc phosphate conversion coatings and polyacid coupling primers for corrosion protection of steel and aluminum, and alkali-catalyzed hydrolysis of polyimide-based materials: Final report, 14:47414 (R;US)

ZINC-BROMINE BATTERIES
Doped carbon electrodes for zinc-halogen batteries. Final report, February 1986-July 1986, 14:47205 (R;US)

ZIRCONIUM
Breakdown of chromium oxide scales in sulfur-containing environments at elevated temperatures, 14:47385 (J;US)
New interpretation of rupture strength using the potential drop technique, 14:47383 (BA;US)

ZIRCONIUM 90
[A proposal for research to use the GANIL accelerator facility at Caen, France, May 30–31, 1988]: Foreign trip report, 14:48434 (R;US)

ZIRCONIUM ALLOYS
Creep behavior of tungsten fiber reinforced niobium metal matrix composites, 14:47351 (R;US)
The interface in tungsten fiber reinforced niobium metal-matrix composites, 14:47421 (R;US)

ZIRCONIUM ISOTOPES
[Isoscalar quadrupole resonances in $^{90,96}Zr$ and $^{112,118,124}Sn$ by inelastic scattering of ^{17}O ions]: Foreign trip report, November 5–December 13, 1988, 14:48452 (R;US)

ZIRCONIUM SILICATES
Radiospectroscopic detection of zirconium silicate defectness, 14:48511 (RA;SU;In Russian)

Contract Number Index

Numbers assigned to DOE contracts announced in documents in this publication are listed. Contract numbers are sorted alphanumerically and list the primary corporate author of the document cited, the citation number, and the report number or other document identification.

Contract No.	Abstract No.	Report No.
AA03	**Stanford Linear Accelerator Center, Menlo Park, CA (USA)**	
	14:48321	SLAC-PUB-5052
AC01-85CE10509	**Meridian Corp., Alexandria, VA (USA)**	
	14:47236	DOE/CE/10509-H1
AC02-76CH00016	**Brookhaven National Lab., Upton, NY (USA)**	
	14:46792	BNL-42836
	14:47237	DOE/CH/00016-H2
	14:47330	BNL-42866
	14:47331	BNL-43052
	14:47414	BNL-43186
	14:47461	BNL-43048
	14:47482	BNL-42981
	14:47780	BNL-42946
	14:47781	BNL-43105
	14:47782	BNL-52195
	14:47790	BNL-42990
	14:47791	BNL-43175
	14:47792	BNL-43204
	14:47799	BNL-41891
	14:47800	BNL-42004
	14:47801	BNL-42699
	14:47802	BNL-42996
	14:47803	BNL-42997
	14:47804	BNL-43100
	14:48292	BNL-43153
	14:48293	BNL-43184
	14:48496	BNL-42810
	14:48667	BNL-43062
	14:48290	BNL-43150
	14:48291	BNL-43151
	USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA)	
	14:46839	CONF-8707212-
	14:47839	CONF-8809203-
	14:47529	Published article
AC02-76CH03000	**Fermi National Accelerator Lab., Batavia, IL (USA)**	
	14:47352	FNAL-TM-1613
	14:47783	FNAL/C-89/182
	14:47784	FNAL-TM-1574
	14:47785	FNAL-TM-1593
	14:47793	FNAL-TM-1603
	14:47794	FNAL-TM-1607
	14:47807	FNAL-TM-1588
	14:47825	FNAL/C-89/170-E
AC02-76CH03073	**Princeton Univ., NJ (USA). Plasma Physics Lab.**	
	14:48659	PPPL-2639
	14:48660	PPPL-2644
AC02-76ER01195	**Illinois Univ., Urbana, IL (USA). Dept. of Physics**	
	14:48296	DOE/ER/01195-T11
	14:48297	DOE/ER/01195-T12
	Stanford Linear Accelerator Center, Menlo Park, CA (USA)	
	14:48321	SLAC-PUB-5052
	14:47527	Published article
AC02-76ER02220	**Institute for Advanced Study, Princeton, NJ (USA)**	
	14:48385	CONF-8902132-1
	14:47839	CONF-8809203-
AC02-83CH10093	**Solar Energy Research Inst., Golden, CO (USA)**	
	14:47027	SERI/SP-231-3520
	Glasstech Solar, Inc., Wheatridge, CO (USA)	
	14:47041	SERI/STR-211-3562
	14:47839	CONF-8809203-
AC02-87ER40318	**Stanford Linear Accelerator Center, Menlo Park, CA (USA)**	
	14:48321	SLAC-PUB-5052
AC03-76SF00098	**Oak Ridge National Lab., TN (USA)**	
	14:47335	CONF-8409210-
	14:47760	CONF-880606-
	14:48486	CONF-8809203-
	14:48163	Published article
	14:48420	Published article
AC03-76SF00515	**Stanford Linear Accelerator Center, Menlo Park, CA (USA)**	
	14:47815	SLAC-339
	14:48320	SLAC-PUB-5047
	14:48321	SLAC-PUB-5052
	14:48357	SLAC-PUB-5057
	14:48418	SLAC-PUB-5031
	14:48419	SLAC-PUB-5095
AC03-76SF00700	**Rockwell International Corp., Canoga Park, CA (USA). Energy Technology Engineering Center**	
	14:47100	ETEC-TDR-89-5
AC03-81ER40050	**Stanford Linear Accelerator Center, Menlo Park, CA (USA)**	
	14:48321	SLAC-PUB-5052
AC03-84CE30806	**Architectural Energy Corp., Boulder, CO (USA)**	
	14:47265	DOE/CE/30806-T3
AC03-89SF17885	**General Atomics, San Diego, CA (USA)**	
	14:47114	GA-A-19823
AC04-76DP00789	**Sandia National Labs., Albuquerque, NM (USA)**	
	14:46983	SAND-88-2744
	14:47040	SAND-89-2009C
	14:47088	SAND-88-1881C
	14:47151	SAND-89-1854C
	14:47152	SAND-89-1878C
	14:47207	SAND-89-2136C
	14:47404	SAND-89-1115C
	14:47444	SAND-88-3338C
	14:47445	SAND-89-0661C
	14:47446	SAND-89-0814C
	14:47447	SAND-89-1116C
	14:47448	SAND-89-1829C
	14:47723	SAND-89-0547
	14:47724	SAND-89-1256
	14:47725	SAND-89-1964C
	14:47767	SAND-89-1954C
	14:47798	SAND-89-0571

Contract No.	Abstract No.	Report No.
	14:47848	SAND–89-1784
	14:47852	SAND–89-0166
	14:47860	SAND–89-0344C
	14:47861	SAND–89-1069C
	14:47875	CONF-870961–Vol.1
	14:47899	CONF-870961–Vol.2
	14:47916	SAND–89-2121C
	14:48164	SAND–89-1019C
	14:48523	SAND–89-1875C
	14:48690	SAND–89-0139C
	14:48691	SAND–89-0283C
	14:48692	SAND–89-1270C
	14:48522	SAND–88-3307C
	Lawrence Livermore National Lab., CA (USA)	
	14:48735	SAND–88-1218
	14:47022	Published article
AC04-88DP43495	**EG and G Mound Applied Technologies, Miamisburg, OH (USA)**	
	14:48729	MLM–3598
	14:48730	MLM-MU–89-68-0001
AC05-76OR00033	**Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA)**	
	14:46989	CONF-881054–Vol.3
AC05-84OR21400	**Oak Ridge National Lab., TN (USA)**	
	14:46881	ORNL/FTR–2842
	14:46882	ORNL/FTR–3151
	14:46921	ORNL/FTR–2801
	14:46958	CONF-890854–12
	14:46971	ORNL/FTR–3177
	14:46972	ORNL/FTR–3230
	14:46973	ORNL/FTR–3346
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	14:47996	ORNL/RASA–88/40
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	14:48459	ORNL/FTR–3222
	14:48476	ORNL/FTR–2932
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	14:48478	ORNL/FTR–2940
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	14:48481	ORNL/FTR–2992
	14:48482	ORNL/FTR–3025
	14:48483	ORNL/FTR–3167
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	14:48520	ORNL/FTR–3281
	14:48521	ORNL/FTR–3308

Contract No.	Abstract No.	Report No.
	14:48533	ORNL/FTR–3092
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	14:48670	CONF-8909184–1
	14:48688	ORNL/FTR–2843
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	14:48721	CONF-8908137–1
	14:48722	CONF-8908137–2
	14:48746	ORNL/TM–11142
	14:48747	ORNL/TM–11215
	14:47103	ORNL/Sub–88-SC557/1
	14:47374	ORNL/Sub–85-27421/03
	Universal Energy Systems, Inc., Dayton, OH (USA)	
	14:46824	ORNL/Sub–86-95901/01
	Georgia Inst. of Tech., Atlanta, GA (USA). Research Inst.	
	14:47401	ORNL/Sub–87-00184/01
	USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA)	
	14:46800	CONF-8707212–
	14:46806	CONF-8707212–
	Nuclear Regulatory Commission, Washington, DC (USA). Div. of Engineering	
	14:47105	NUREG/CR–5338
	14:47147	NUREG/CR–4234-Vol.2
	Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA)	
	14:47005	CONF-8909110–4
	Oak Ridge National Lab., TN (USA). Performance Assurance Project Office	
	14:47246	DOE/OR/21400–T394
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	14:47116	ORNL/RSIC–52
	Peyton (Gary R.), Champaign, IL (USA)	
	14:48025	ORNL/Sub–89-SD212V/1
	14:48485	CONF-8809203–
	14:48281	CONF-8811181–
AC05-84OS21400	**Oak Ridge Y-12 Plant, TN (USA)**	
	14:47377	Y/DX–833
AC05-84OT21400	**Oak Ridge Gaseous Diffusion Plant, TN (USA)**	
	14:46968	K/QT–230-R
	Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA)	
	14:47322	K/ITP–290
AC06-76RL01830	**Pacific Northwest Lab., Richland, WA (USA)**	
	14:46933	PNL–6969
	14:46978	PNL–6989
	14:46979	PNL-SA–16788
	14:46980	PNL-SA–16832
	14:46981	PNL-SA–16877
	14:46982	PNL-SA–16884
	14:47073	PNL–6959
	14:47101	PNL-SA–17011
	14:47202	PNL–6845
	14:47294	PNL-SA–17246
	14:47837	PNL–6952
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	14:48706	PNL-SA–17193
	Nuclear Regulatory Commission, Washington, DC (USA). Div. of Regulatory Applications	
	14:47148	NUREG/CR–5396
	Analysas Corp., Oak Ridge, TN (USA)	
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AC06-81ER40048	**Washington Univ., Seattle, WA (USA)**	
	14:48465	DOE/ER/40048–224-L9
	Washington Univ., Seattle, WA (USA). Dept. of Physics	
	14:47823	DOE/ER/40048–221-LP
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	Washington Univ., Seattle, WA (USA). Nuclear Physics Lab.	
	14:47805	DOE/ER/40048–227-L9
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	14:48430	DOE/ER/40048–226-L9
AC06-84RL10421	**General Electric Co., Shippingport, PA (USA). Nuclear Energy Business Operations**	
	14:47002	DOE/SSDP–O070
	14:47134	DOE/SSDP–0074
	Westinghouse Hanford Co., Shippingport, PA (USA)	
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	General Electric Co., Shippingport, PA (USA)	
	14:47001	DOE/SSDP–0073
AC06-87RL10930	**Westinghouse Hanford Co., Richland, WA (USA)**	
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	14:47124	WHC-SP–0084
	General Electric Co., Shippingport, PA (USA). Nuclear Energy Business Operations	
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	USDOE Richland Operations Office, WA (USA)	
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	Westinghouse Hanford Co., Shippingport, PA (USA)	
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	General Electric Co., Shippingport, PA (USA)	
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AC07-76ID01570	**EG and G Idaho, Inc., Idaho Falls, ID (USA)**	
	14:46965	EGG-M–89245
	14:47003	EGG-M–89176
	14:47135	EGG-EAST–8382
	14:47136	EGG-M–89091
	14:47285	EGG-M–88520
	14:48742	EGG-M–89040
	USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA)	
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	Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA)	
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AC09-76SR00001	**Du Pont de Nemours (E.I.) and Co., Aiken, SC (USA). Savannah River Lab.**	
	14:47122	DPST–88-1004
	Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA)	
	14:46955	CONF-881054–Vol.5
AC09-89SR18035	**Westinghouse Savannah River Co., Aiken, SC (USA)**	
	14:47006	DP-MS–89-46
	14:47472	DP-MS–89-33
AC21-85MC22012	**KOH Systems, Inc., Rockville, MD (USA)**	
	14:47284	DOE/MC/22012–2726

Contract No.	Abstract No.	Report No.
AC21-85MC22137	West Virginia Univ., Morgantown, WV (USA). Dept. of Mechanical and Aerospace Engineering	
	14:46815	DOE/MC/22137–2704-Vol.1
AC21-85MC22181	General Electric Co., Schenectady, NY (USA). Corporate Research and Development Center	
	14:47305	DOE/MC/22181–2694
AC21-86MC21023	Foster Wheeler Development Corp., Livingston, NJ (USA)	
	14:47074	DOE/MC/21023–2716
AC21-86MC23251	Battelle Columbus Div., OH (USA)	
	14:46840	DOE/MC/23251–2730
AC21-87MC23288	City Coll., New York, NY (USA)	
	14:46817	DOE/MC/23288–2697
AC21-88MC24092	Synfuels Engineering and Development, Inc., Rifle, CO (USA)	
	14:46923	DOE/MC/24092–2725
AC22-84PC70018	Consolidation Coal Co., Library, PA (USA). Research and Development Dept.	
	14:46793	CONF-880915–3
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AC22-87PC79680	Montana State Univ., Bozeman, MT (USA). Dept. of Electrical Engineering	
	14:47257	DOE/PC/79680–T1
AC22-87PC79881	Manufacturing and Technology Conversion International, Inc., Santa Fe Springs, CA (USA)	
	14:46790	DOE/PC/79881–T1
AC22-87PC90274	TRW Space and Technology Group, Redondo Beach, CA (USA). Applied Technology Div.	
	14:47258	DOE/PC/90274–T5
AC22-88PC88818	Hydrocarbon Research, Inc., Lawrenceville, NJ (USA)	
	14:46821	DOE/PC/88818–2
AC79-85BP24760	University of Southern California, Los Angeles, CA (USA). Inst. of Safety and Systems Management	
	14:47080	DOE/BP–972
AI01-87ER60590	National Research Council, Washington, DC (USA). Board on Atmospheric Sciences and Climate	
	14:47924	CONF-8803229–
AI03-86SF16310	National Aeronautics and Space Administration, Cleveland, OH (USA). Lewis Research Center	
	14:47351	DOE/NASA/16310–11
	14:47421	DOE/NASA/16310–10
AI21-83MC20422	Geological Survey, Denver, CO (USA)	
	14:46905	DOE/MC/20422–2729
AM79-86BP64849	Knudson Engineering, Inc., Portland, OR (USA)	
	14:47282	DOE/BP/64849–1
AS03-76ER72012	California Inst. of Tech., Pasadena, CA (USA)	
	14:48285	DOE/ER/72012–T8
AS05-76ER03065	Duke Univ., Durham, NC (USA). Dept. of Physics	
	14:48289	DOE/ER/03065–54
AS05-79ER10427	Oak Ridge National Lab., TN (USA)	
	14:47337	CONF-8409210–
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FC08-87DP10618	Cornell Univ., Ithaca, NY (USA). Lab. of Plasma Studies	
	14:48671	DOE/DP/10618–T2
FC21-87MC23277	Texaco, Inc., Montebello, CA (USA). Montebello Research Lab.	
	14:46816	DOE/MC/23277–2731
FC22-83FE60149	National Inst. for Petroleum and Energy Research, Bartlesville, OK (USA)	
	14:46836	NIPER–200
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	14:46892	NIPER–308
	14:46893	NIPER–400
FG01-81ER40020	National Research Council, Washington, DC (USA). Panel on Basic Nuclear Data Compilations	
	14:48429	DOE/ER/40020–T4
FG01-86CE15290	Stainbrook Engineering, Meadville, PA (USA)	
	14:47717	DOE/CE/15290–T1
FG01-88CE15401	CeramPhysics, Inc., Westerville, OH (USA)	
	14:47843	DOE/CE/15401–T4
FG01-88CE26576	Fleming Group, East Syracuse, NY (USA)	
	14:47296	DOE/CE/26576–T2
FG01-89CE15412	Welding Consultants, Inc., Columbus, OH (USA)	
	14:47349	DOE/CE/15412–T1
	14:47528	Published article
FG02-84ER60242	Colorado Univ., Boulder, CO (USA). Inst. of Arctic and Alpine Research	
	14:47972	DOE/ER/60242–T1
	Walker Geobotanical Surveys, Lafayette, CO (USA)	
	14:47973	DOE/ER/60242–T2
FG02-85CE40740	Florida Univ., Gainesville, FL (USA)	
	14:47283	DOE/CE/40740–T4
FG02-85ER13329	Massachusetts Univ., Amherst, MA (USA). Dept. of Chemical Engineering	
	14:47718	DOE/ER/13329–3
FG02-85ER52122	Wisconsin Univ., Madison, WI (USA). Dept. of Electrical and Computer Engineering	
	14:48672	DOE/ER/52122–4
FG02-86ER13592	Dartmouth Coll., Hanover, NH (USA). Dept. of Chemistry	
	14:47539	DOE/ER/13592–4
FG02-86ER13615	Pennsylvania Univ., Philadelphia, PA (USA). Board of Trustees	
	14:47024	DOE/ER/13615–3
FG02-86ER13616	Indiana Univ., Bloomington, IN (USA)	
	14:46814	DOE/ER/13616–3
FG02-86ER13625	Indiana Univ., Bloomington, IN (USA)	
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FG02-86ER45274	Wisconsin Univ., Madison, WI (USA)	
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FG02-86ER53218	Wisconsin Univ., Madison, WI (USA). Dept. of Electrical and Computer Engineering	
	14:48585	DOE/ER/53218–11
	14:47851	CONF-880606–
FG02-87ER13781	Pittsburgh Univ., PA (USA). Dept. of Chemistry	
	14:47484	DOE/ER/13781–2
FG02-87ER25026	Illinois Univ., Urbana, IL (USA). Dept. of Computer Science	
	14:48724	DOE/ER/25026–32
	14:48725	DOE/ER/25026–33
FG02-88ER60638	Rochester Univ., NY (USA). School of Medicine and Dentistry	
	14:48087	DOE/ER/60638–1
	14:47541	Published article
FG03-85ER60305	City of Hope National Medical Center, Duarte, CA (USA)	
	14:48086	DOE/ER/60305–T1
FG03-85SF15754	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Atlanta, GA (USA)	
	14:47047	DOE/SF/15754–T1

Contract No.	Abstract No.	Report No.
FG03-86ER45230	Brookhaven National Lab., Upton, NY (USA)	
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FG05-84ER45054	Oak Ridge National Lab., TN (USA)	
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FG05-84ER45071	Oak Ridge National Lab., TN (USA)	
	14:47337	CONF-8409210–
FG05-84ER45140	North Carolina Agricultural and Technical State Univ., Greensboro, NC (USA)	
	14:47419	DOE/ER/45140–T1
FG05-85ER40215	Oklahoma State Univ., Stillwater, OK (USA). Dept. of Physics	
	14:48325	DOE/ER/40215–T9
FG05-86ER40256	Texas A and M Univ., College Station, TX (USA). Cyclotron Inst.	
	14:48245	DOE/ER/40256–4
FG05-86ER45259	Argonne National Lab., IL (USA)	
	14:47347	CONF-8906205–1
FG05-86ER60393	Louisiana State Univ., Baton Rouge, LA (USA). Dept. of Zoology and Physiology	
	14:48121	CONF-881190–4
	14:47535	Published article
FG05-87ER40310	Texas A and M Univ., College Station, TX (USA). Cyclotron Inst.	
	14:47824	DOE/ER/40310–3
FG05-87ER40322	Maryland Univ., College Park, MD (USA). Dept. of Physics and Astronomy	
	14:48466	DOE/ER/40322–075
FG05-88ER13821	Texas Univ., Austin, TX (USA). Dept. of Physics	
	14:48498	DOE/ER/13821–2
FG05-88ER13834	Tennessee Univ., Knoxville, TN (USA). Dept. of Physics and Astronomy	
	14:47350	DOE/ER/13834–7
FG05-88ER40399	Texas A and M Univ., College Station, TX (USA)	
	14:48295	CONF-8811171–5
	Texas A and M Univ., College Station, TX (USA). Dept. of Physics	
	14:48298	DOE/ER/40399–2
FG05-88ER60728	Miami Univ., FL (USA). School of Medicine	
	14:48102	CONF-8906203–1
FG06-84ER45163	Washington Univ., Seattle, WA (USA). Dept. of Physics	
	14:47471	DOE/ER/45163–12
FG06-86ER25019	Washington Univ., Seattle, WA (USA)	
	14:47742	DOE/ER/25019–11
FG06-87ER13664	Oregon Graduate Center, Beaverton, OR (USA). Dept. of Chemical and Biological Sciences	
	14:47483	DOE/ER/13664–3
FG06-88ER13973	Oregon Univ., Eugene, OR (USA). Dept. of Physics	
	14:47741	DOE/ER/13973–1
FG06-88ER25061	Washington Univ., Seattle, WA (USA). Dept. of Applied Mathematics	
	14:48284	DOE/ER/25061–1
FG07-83ID12467	Massachusetts Inst. of Tech., Cambridge, MA (USA). Dept. of Materials Science and Engineering	
	14:47485	DOE/ID/12467–3
FG07-87ID12693	Oregon Inst. of Tech., Klamath Falls, OR (USA)	
	14:47057	DOE/ID/12693–3
	14:47530	Published article
FG22-85PC80502	Auburn Univ., AL (USA). Dept. of Chemical Engineering	
	14:46898	DOE/PC/80502–T14
FG22-85PC80538	USDOE Assistant Secretary for Fossil Energy, Washington, DC (USA)	
	14:46805	CONF-8707212–
FG22-85PC80908	Lehigh Univ., Bethlehem, PA (USA). Dept. of Chemistry	
	14:46819	DOE/PC/80908–12
FG22-85PC80910	Advanced Fuel Research, Inc., East Hartford, CT (USA)	
	14:46820	DOE/PC/80910–T6
FG22-86PC90517	Missouri Univ., Columbia, MO (USA). Coll. of Engineering	
	14:46845	DOE/PC/90517–T3
FG22-86PC90529	Brown Univ., Providence, RI (USA). Div. of Engineering	
	14:46822	DOE/PC/90529–10
FG22-88PC88912	California State Univ., Long Beach, CA (USA)	
	14:46833	DOE/PC/88912–T2
W-31-109-ENG-38	Oak Ridge National Lab., TN (USA)	
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	Martin Marietta Energy Systems, Inc., Oak Ridge, TN (USA)	
	14:47214	CONF-881054–Vol.3
	14:47384	Published article
	14:47385	Published article
	14:47556	Published article
W-31109-ENG-38	Argonne National Lab., Idaho Falls, ID (USA)	
	14:47133	CONF-890741–2
	Argonne National Lab., IL (USA)	
	14:46832	CONF-8904133–1
	14:47078	CONF-890815–27
	14:47084	CONF-8907137–1
	14:47099	CONF-890721–42
	14:47131	CONF-890721–39
	14:47132	CONF-890721–40
	14:47261	CONF-890815–26
	14:47329	ANL–80-120-Rev.1
	14:47347	CONF-8906205–1
	14:47388	ANL/FE–89/5
	14:47418	CONF-8907138–1
	14:48323	ANL-HEP-CP–89-80
	14:48324	CONF-8906210–2
	14:48426	ANL–89/11
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	Argonne National Lab., IL (USA). Fusion Power Program	
	14:48666	ANL/FPP/TM–242
	Los Alamos National Lab., NM (USA)	
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W-7405-ENG-36	Los Alamos National Lab., NM (USA)	
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	14:47370	LA-UR–89-2869
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	14:47766	LA-UR–89-2921
	14:47786	LA-UR–89-2894

Contract No.	Abstract No.	Report No.
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	14:48473	LA-UR-89-2744
	14:48474	LA-UR-89-2788
	14:48475	LA-UR-89-2981
	14:48518	LA-UR-89-2324
	14:48519	LA-UR-89-2718
	14:48531	LA-UR-89-2680
	14:48532	LA-UR-89-2885
	14:48582	LA-11686-C
	14:48656	LA-UR-89-2710
	14:48727	LA-UR-89-2660
	14:48728	LA-UR-89-2828
	14:48752	LA-11572-MS
	Deuteron, Inc., Winchester, MA (USA)	
	14:47845	LA-SUB-89-6
W-7405-ENG-48	**California Univ., Davis, CA (USA)**	
	14:47849	UCRL-21166
	Sandia National Labs., Albuquerque, NM (USA)	
	14:47878	CONF-870961-Vol.1
	14:47880	CONF-870961-Vol.1
	14:47885	CONF-870961-Vol.1
	14:47894	CONF-870961-Vol.2
	14:47895	CONF-870961-Vol.2
	14:47896	CONF-870961-Vol.2
	14:47897	CONF-870961-Vol.2
	14:47900	CONF-870961-Vol.2
	Pacific Northwest Lab., Richland, WA (USA)	
	14:46980	PNL-SA-16832
	Lawrence Livermore National Lab., CA (USA)	
	14:47018	UCRL-100768
	14:47019	UCRL-100943
	14:47245	UCRL-53929-88
	14:47405	UCRL-100094
	14:47726	UCRL-100270
	14:47727	UCRL-100357-Rev.1
	14:47728	UCRL-100403
	14:47729	UCRL-101777
	14:47748	UCRL-100862-Rev.1
	14:47768	UCRL-100642
	14:47769	UCRL-101192
	14:47838	UCRL-100784
	14:47841	UCID-21687
	14:47842	UCID-21739
	14:47850	UCRL-101721
	14:47862	UCID-21692
	14:47863	UCRL-100835
	14:47864	UCRL-101617
	14:47865	UCRL-101680
	14:47914	UCID-21528
	14:47915	CONF-890398-
	14:47917	UCRL-101542
	14:47986	UCID-21676
	14:48094	UCRL-101588
	14:48155	UCRL-21064
	14:48227	UCRL-101436
	14:48228	UCRL-101753
	14:48278	UCRL-101228
	14:48288	UCID-21673
	14:48460	UCRL-101297
	14:48484	UCRL-100547
	14:48524	UCRL-100804
	14:48525	UCRL-101616
	14:48535	UCRL-100695
	14:48577	UCID-21767
	14:48578	UCRL-101396
	14:48662	UCRL-101322
	14:48663	UCRL-101395
	14:48693	UCID-21519-Rev.1
	14:48694	UCID-21737
	14:48695	UCRL-100530
	14:48696	UCRL-101646
	14:48708	UCID-21723
	14:48736	UCID-21695
	14:48737	UCID-21768
	14:48748	UCID-21679
	14:48754	UCID-21722
	14:47279	UCRL-21156
	14:48661	UCRL-21225
	14:48707	UCID-21684
	14:48749	UCID-21680
	14:48750	UCID-21765
W-7405-ENG-82	**Los Alamos National Lab., NM (USA)**	
	14:48531	LA-UR-89-2680
	14:47023	Published article
	14:47532	Published article
	14:47533	Published article

Report Number Index

The report number index consists of the alphanumeric identifiers assigned to report literature as well as patent and conference literature cited in this publication. Entries provide the abstract number; the source(s) of availability of the document; the GPO file prefix for GPO depository library documents; the order number for OSTI and NTIS report ordering purposes; and, if the document was distributed under the DOE distribution program, the category number is shown for paper copy (PC), microfiche (MF), or no distribution (ND). These categories are included to assist DOE librarians in responding to requests for reports in their collections. The index also lists secondary numbers, with the corresponding abstract numbers and cross-references to other identifying numbers.

Report Number	*Abstract Number*	*Source of Availability*	*GPO Dep.*	*Order Number*	*Distribution Category*
AD-A–					
204228/1/XAB	14:47737	NTIS, PC A02/MF A01			
204555/7/XAB	14:48461	NTIS, PC A04/MF A01			
205371/8/XAB	14:48462	NTIS, PC A05/MF A01			
205471/6/XAB	14:47738	NTIS, PC A08/MF A01			
205543/2/XAB	14:48232	NTIS, PC A03/MF A01			
205632/3/XAB	14:47327	NTIS, PC A02/MF A01			
205673/7/XAB	14:47248	NTIS, PC A03/MF A01			
205704/0/XAB	14:48233	NTIS, PC A03/MF A01			
205811/3/XAB	14:48118	NTIS, PC A03/MF A01			
205953/3/XAB	14:47386	NTIS, PC A03/MF A01			
206002/8/XAB	14:47866	NTIS, PC A04/MF A01			
206061/4/XAB	14:47408	NTIS, PC A03/MF A01			
206276/8/XAB	14:48017	NTIS, PC A06/MF A01			
206457/4/XAB	14:48234	NTIS, PC A04/MF A01			
206659/5/XAB	14:48018	NTIS, PC A07/MF A01			
206665/2/XAB	14:48174	NTIS, PC A02/MF A01			
206734/6/XAB	14:48494	NTIS, PC A03/MF A01			
207017/5/XAB	14:48282	NTIS, PC A20/MF A01			
207020/9/XAB	14:47387	NTIS, PC A03/MF A01			
207188/4/XAB	14:48157	NTIS, PC A03/MF A01			
207190/0/XAB	14:48712	NTIS, PC A03/MF A01			
207197/5/XAB	14:47409	NTIS, PC A03/MF A01			
207198/3/XAB	14:47410	NTIS, PC A05/MF A01			
207201/5/XAB	14:48081	NTIS, PC A04/MF A01			
207216/3/XAB	14:48243	NTIS, PC A02/MF A01			
207220/5/XAB	14:47411	NTIS, PC A05/MF A01			
207235/3/XAB	14:47712	NTIS, PC A06/MF A01			
207261/9/XAB	14:47739	NTIS, PC A05/MF A01			
207271/8/XAB	14:47412	NTIS, PC A06/MF A01			
207275/9/XAB	14:48158	NTIS, PC A03/MF A01			
207310/4/XAB	14:48583	NTIS, PC A04/MF A01			
207311/2/XAB	14:48175	NTIS, PC A04/MF A01			
207318/7/XAB	14:48713	NTIS, PC A03/MF A01			
207320/3/XAB	14:48714	NTIS, PC A03/MF A01			
207321/1/XAB	14:48715	NTIS, PC A02/MF A01			
207333/6/XAB	14:47713	NTIS, PC A04/MF A01			
207339/3/XAB	14:47321	NTIS, PC A04/MF A01			
207372/4/XAB	14:46901	NTIS, PC A11/MF A01			
207373/2/XAB	14:47320	NTIS, PC A03/MF A01			
207375/7/XAB	14:47319	NTIS, PC A06/MF A01			
207390/6/XAB	14:48084	NTIS, PC A03/MF A01			
207395/5/XAB	14:47714	NTIS, PC A02/MF A01			
207396/3/XAB	14:48235	NTIS, PC A03/MF A01			
207412/8/XAB	14:47715	NTIS, PC A06/MF A01			
207416/9/XAB	14:48236	NTIS, PC A02/MF A01			
207419/3/XAB	14:47867	NTIS, PC A04/MF A01			
207420/1/XAB	14:48463	NTIS, PC A07/MF A01			
207430/0/XAB	14:47762	NTIS, PC A02/MF A01			
207442/5/XAB	14:48538	NTIS, PC A02/MF A01			
207446/6/XAB	14:48445	NTIS, PC A12/MF A01			
207449/0/XAB	14:48751	NTIS, PC A05/MF A01			
207466/4/XAB	14:47868	NTIS, PC A06/MF A01			
207467/2/XAB	14:47869	NTIS, PC A03/MF A01			
207484/7/XAB	14:47413	NTIS, PC A02/MF A01			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
207547/1/XAB	14:48237	NTIS, PC A03/MF A01			
207555/4/XAB	14:47046	NTIS, PC A02/MF A01			
207557/0/XAB	14:47853	NTIS, PC A03/MF A01			
207569/5/XAB	14:47740	NTIS, PC A05/MF A01			
207576/0/XAB	14:47260	NTIS, PC A05/MF A01			
207589/3/XAB	14:47763	NTIS, PC A03/MF A01			
207593/5/XAB	14:48099	NTIS, PC A02/MF A01			
207612/3/XAB	14:47204	NTIS, PC A05/MF A01			
207647/9/XAB	14:47328	NTIS, PC A03/MF A01			
207705/5/XAB	14:48716	NTIS, PC A14/MF A01			
207707/1/XAB	14:47977	NTIS, PC A18/MF A01			
207708/9/XAB	14:48113	NTIS, PC A03/MF A01			
207734/5/XAB	14:48495	NTIS, PC A03/MF A01			
207809/5/XAB	14:48717	NTIS, PC A02/MF A01			
207833/5/XAB	14:48718	NTIS, PC A10/MF A01			
207877/2/XAB	14:48719	NTIS, PC A05/MF A01			
207917/6/XAB	14:48119	NTIS, PC A02/MF A01			
207985/3/XAB	14:48283	NTIS, PC A04/MF A01			
208149/5/XAB	14:48085	NTIS, PC A02/MF A01			
208198/2/XAB	14:48159	NTIS, PC A05/MF A01			
AD-P–					
005777/8/XAB	14:48720	NTIS, PC A03/MF A01			
AEEW-R–					
2274	14:46964	*See* DOE-RW–87.113			
AEI-TR–					
85290-01	14:48283	*See* AD-A–207985/3/XAB			
AERE-M–					
3618(rev.)	14:48120	H.M. Stationery Office, London, price Pound 5.00			
AERE-R–					
12362	14:47959	H.M. Stationery Office, London, price Pound 10.25			
12820(rev.)	14:47481	H.M. Stationery Office, London, price Pound 12.00			
13255(ed.2)	14:47987	NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS		DE90601274/JAW	
13389	14:47988	H.M. Stationery Office, London, price Pound 8.00			
13424	14:47820	H.M. Stationery Office, London, price Pound 10.00			
AFGL-TR–					
87-0245	14:48232	*See* AD-A–205543/2/XAB			
88-0251	14:48233	*See* AD-A–205704/0/XAB			
89-0054	14:48174	*See* AD-A–206665/2/XAB			
89-0113	14:48236	*See* AD-A–207416/9/XAB			
AFIT/GNE/ENP–					
89M-5	14:48463	*See* AD-A–207420/1/XAB			
89M-9	14:47867	*See* AD-A–207419/3/XAB			
AFME–					
85.91.1003.2	14:47048	NTIS (US Sales Only), PC A06/MF A01		DE89764083/JAW	
86.02.0063	14:47281	NTIS (US Sales Only), PC A05/MF A01		DE89764077/JAW	
AFME-Z–					
0089	14:47042	NTIS (US Sales Only), PC A05/MF A01		DE89764082/JAW	
AFRRI-SR–					
88-47	14:48118	*See* AD-A–205811/3/XAB			
89-13	14:48119	*See* AD-A–207917/6/XAB			
AIRESEARCH–					
86-60365	14:47395	*See* N–89-19421			
AMSEL-NV-TR–					
0077	14:47715	*See* AD-A–207412/8/XAB			
AMSMI/TR-RD-SS–					
88-10	14:47853	*See* AD-A–207557/0/XAB			
ANL–					
80-120-Rev.1	14:47329	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016686/JAW	MF-406
89/11	14:48426	NTIS, PC A15/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90000003/JAW	PC-410
ANL-HEP-CP–					
89-80	14:48323	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016913/JAW	MF-414
ANL/FE–					
89/5	14:47388	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016703/JAW	PC-114
ANL/FPP/TM–					
242	14:48666	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016704/JAW	PC-420
ANL/NDM–					
113	14:48487	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017897/JAW	MF-413

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
ANSTO/E–					
669	14:47971	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601282/JAW	
675	14:46984	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601420/JAW	
681	14:47012	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601592/JAW	
ANU-P–					
1001	14:48453	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601121/JAW	
1005	14:48454	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601122/JAW	
1011	14:48441	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601112/JAW	
1012	14:48442	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601113/JAW	
1016	14:48427	NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS		DE90601106/JAW	
1018	14:48449	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601117/JAW	
1020	14:48450	NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS		DE90601118/JAW	
1024	14:48464	NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS		DE90601105/JAW	
1025	14:48455	NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS		DE90601123/JAW	
1026	14:48443	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601114/JAW	
1029	14:48438	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601108/JAW	
1031	14:48456	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601124/JAW	
1033	14:48451	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601119/JAW	
1034	14:48428	NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS		DE90601107/JAW	
1035	14:48439	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601109/JAW	
997	14:48446	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601115/JAW	
ANU/TPP–					
88/01	14:48584	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601005/JAW	
ARAP–					
587	14:47957	*See* PB–89-197388/XAB			
ATR–					
86(8139)-5	14:47821	NTIS, PC A02/MF A01			
AVSCOM-TR–					
88-C-007	14:47776	*See* N–89-20472			
89-C-001	14:46903	*See* N–89-21051			
BNL–					
41891	14:47799	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017599/JAW	MF-414
42004	14:47800	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017610/JAW	MF-414
42699	14:47801	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90000096/JAW	MF-414
42810	14:48496	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017600/JAW	MF-414
42836	14:46792	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000035/JAW	MF-109
42866	14:47330	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017621/JAW	MF-404
42946	14:47780	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017831/JAW	MF-414
42981	14:47482	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017614/JAW	MF-401
42990	14:47790	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90000026/JAW	MF-414
42996	14:47802	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017627/JAW	MF-414
42997	14:47803	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017617/JAW	MF-414
43048	14:47461	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017622/JAW	MF-400
43052	14:47331	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017603/JAW	MF-404
43062	14:48667	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017602/JAW	MF-410
43100	14:47804	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017607/JAW	MF-414
43105	14:47781	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017605/JAW	MF-410
43150	14:48290	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017832/JAW	MF-414
43151	14:48291	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017833/JAW	MF-414
43153	14:48292	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90000032/JAW	MF-414
43175	14:47791	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017827/JAW	MF-414

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
43184	14:48293	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90000029/JAW	MF-414
43186	14:47414	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017597/JAW	
43204	14:47792	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90000107/JAW	MF-414
52195	14:47782	NTIS, PC A13/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90000524/JAW	PC-414
BONN-IR–					
88-43	14:47822	NTIS (US Sales Only), PC A04/MF A01		DE90702768/JAW	
88-62	14:48294	NTIS (US Sales Only), PC A07/MF A01		DE90702767/JAW	
BR–					
82(11.102)	14:48015	*See* TR-EL–82-4/82(11.102)			
82(11.99)	14:48014	*See* TR-EL–82-4/82(11.99)			
89(7)	14:47973	*See* DOE/ER/60242–T2			
BTs–					
23145	14:47359	*See* INIS-SU–112			
BUMINES–					
9017795	14:47854	OSTI; Bureau of Mines, Pittsburgh Research Center, Pittsburgh, PA 15222		TI89017795/JAW	
CAA-RP–					
88-1	14:47869	*See* AD-A–207467/2/XAB			
CAA-TP–					
89-122	14:47868	*See* AD-A–207466/4/XAB			
CAM–					
8806	14:47403	*See* PB–89-194088/XAB			
CBP/TRS–					
24/88	14:48050	*See* PB–89-207484/XAB			
CE–					
02444	14:47026	*See* IGCE–7609			
CEA-CONF–					
9455	14:47332	NTIS (US Sales Only), PC A02/MF A01		DE90701464/JAW	
9456	14:47333	NTIS (US Sales Only), PC A02/MF A01		DE90701462/JAW	
9484	14:47334	NTIS (US Sales Only), PC A02/MF A01		DE90701463/JAW	
9774	14:48100	NTIS (US Sales Only), PC A03/MF A01		DE90701461/JAW	
CEA-N–					
2599	14:48488	NTIS (US Sales Only), PC A03/MF A01		DE90701451/JAW	
CEA-TR–					
2326	14:47125	NTIS (US Sales Only), PC A03/MF A01		DE90701453/JAW	
2327	14:47126	NTIS (US Sales Only), PC A03/MF A01		DE90701454/JAW	
2336	14:47127	NTIS (US Sales Only), PC A02/MF A01		DE90701456/JAW	
2367	14:47128	NTIS (US Sales Only), PC A03/MF A01		DE90701459/JAW	
2373	14:47545	NTIS (US Sales Only), PC A03/MF A01		DE90701458/JAW	
2374	14:47546	NTIS (US Sales Only), PC A03/MF A01		DE90701457/JAW	
2433	14:48047	NTIS (US Sales Only), PC A02/MF A01		DE90701460/JAW	
2468	14:47129	NTIS (US Sales Only), PC A03/MF A01		DE90701455/JAW	
2469	14:47130	NTIS (US Sales Only), PC A03/MF A01		DE90701452/JAW	
CERL-TR-E–					
89/07	14:47248	*See* AD-A–205673/7/XAB			
CONF-850421–		(2. spring meeting of the Materials Research Society; San Francisco, CA (USA); 15-18 Apr 1985)			
	14:47449	Materials Research Society, 9800 Mc Knight Rd., Suite 327, Pittsburgh, PA 15237			
CONF-8512141–		(Oxygen, carbon, hydrogen and nitrogen in crystalline silicon; Boston, MA (USA); 2-5 Dec 1985)			
	14:47450	Materials Research Society, 9800 Mc Knight Rd., Suite 327, Pittsburgh, PA 15237			
CONF-860610–		(American Nuclear Society annual meeting; Reno, NV (USA); 15-20 Jun 1986)			
	14:48697				
CONF-870577–		(International symposium on acidification and water pathways; Bolkesjo (Norway); 4-8 May 1987)			
Vol.2	14:48012	*See* NEI-NO–83			
CONF-8707133–		(International electron molecule scattering and photoionization meeting; Daresbury (UK); 18-19 Jul 1987)			
	14:48251	*See* FIAS-R–188			
CONF-8707205–		(Case for Mars 3 conference; Boulder, CO (USA); 18-22 Jul 1987)			
	14:47263	*See* N–89-20545			
CONF-8710111–		(15. water reactor safety information meeting (WRSM-15); Gaithersburg, MD (USA); 26-30 Oct 1987)			
	14:47163				
	14:47164				

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
	14:47165				
CONF-8711195–		(American Nuclear Society winter meeting; Los Angeles, CA (USA); 15-19 Nov 1987)			
	14:47198				
	14:47199				
	14:47200				
	14:47730				
	14:47731				
	14:48703				
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CONF-8711245–		(Workshop on computers applications for nuclear powers and industrial process plant operation and control; Rome (Italy); 19-20 Nov 1987)			
2	14:47110	ENEA, Viale Regina Margherita, 125 Roma, Italy			
CONF-8712145–		(3. seminar on physics of e^+e^- interactions; Dubna (USSR); 8-9 Dec 1987)			
	14:48316	*See* JINR-E–2-88-363			
CONF-8802150–		(1. status colloquium on the Water-Waste-Soil Project; Karlsruhe (Germany, F.R.); 23 Feb 1988)			
	14:48021	*See* KFK-PWAB–1			
CONF-8803229–		(Joint symposium on ozone depletion, greenhouse gases and climate change; Washington, DC (USA); 23 Mar 1988)			
	14:47924	NTIS, PC A07/MF A01; OSTI; National Academy Press, 2101 Constitution Ave., NW, Washington, DC 20418 $20.00; GPO Dep.	E 1.99:	DE89016111/JAW	MF-402
CONF-880504–		(90. annual meeting of American Ceramic Society; Cincinnati, OH (USA); 1-5 May 1988)			
	14:47396	*See* N–89-20252			
CONF-880505–		(3. topical meeting on tritium technology in fission, fusion and isotopic applications; Toronto (Canada); 1-6 May 1988)			
	14:47166				
	14:48700				
	14:48701				
	14:48702				
CONF-880606–		(10. symposium on thermophysical properties; Gaithersburg, MD (USA); 20-23 Jun 1988)			
	14:47526				
	14:47759				
	14:47760				
	14:47851				
CONF-880607–		(33. ASME international gas turbine and aeroengine congress and exposition; Amsterdam (Netherlands); 5-8 Jun 1988)			
	14:47774	*See* N–89-20135			
CONF-8806392–		(IAEA technical committee meeting on burnup determination of water reactor fuel; Karlsruhe (Germany, F.R.); 13-16 Jun 1988)			
	14:47085	*See* IWGFPT–31			
CONF-8806405–		(Symposium on the hydrogen atom; Pisa (Italy); 30 Jun - 2 jul 1988)			
1	14:48419	*See* SLAC-PUB–5095			
CONF-8806415–		(Workshop of the Strahlenzentrum of the Justus Liebig University Giessen: positron sources; Giessen (Germany, F.R.); 23-24 Jun 1988)			
	14:47014	*See* INIS-mf–11997			
CONF-880676–		(Conference on thermophysics, plasma dynamics and lasers; San Antonio, TX (USA); 27-29 Jun 1988)			
	14:47754	*See* N–89-21025			
CONF-880704–		(6. international conference on crystal-field effects and heavy-fermion physics (ICCHFP-6); Frankfurt am Main (Germany, F.R.); 18-21 Jul 1988)			
	14:47332	*See* CEA-CONF–9455			
CONF-880705–		(International conference on magnetism (ICM '88); Paris (France); 25-29 Jul 1988)			
	14:47333	*See* CEA-CONF–9456			
	14:47334	*See* CEA-CONF–9484			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-880764–		(24. AIAA/ASME/SAE/ASEE joint propulsion conference; Boston, MA (USA); 11-13 Jul 1988)			
7	14:47279	*See* UCRL–21156			
CONF-880812–		(Applied superconductivity conference; San Francisco, CA (USA); 21-25 Aug 1988)			
	14:47732				
CONF-8808269–		(Workshop on cooling of X-ray monochromators on high power beamlines; Tsukuba (Japan); 31 Aug 1988)			
	14:47812	*See* KEK–88-15			
CONF-880867–		(24. international Rochester conference on high energy physics; Munich (Germany, F.R.); 4-10 Aug 1988)			
27	14:48292	*See* BNL–43153			
CONF-8809143–		(International symposium on hypernuclear and low-energy kaon physics; Padova (Italy); 12-16 Sep 1988)			
	14:48348	*See* IPNO-DRE–88-28			
CONF-880915–		(5. annual international Pittsburgh coal conference; Pittsburgh, PA (USA); 12-16 Sep 1988)			
3	14:46793	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017626/JAW	MF-108
CONF-8809203–		(Quark Matter '88: 7th international conference on ultrarelativistic nucleus-nucleus collisions; Lenox, MA (USA); 26-30 Sep 1988)			
	14:47789				
	14:47839				
	14:48421				
	14:48440				
	14:48444				
	14:48485				
	14:48486				
CONF-8809373–		(3. international workshop on mathematical aspects of fluid and plasma dynamics; Salice Terme (Italy); 26-30 Sep 1988)			
	14:48515	*See* IPP–6/277			
CONF-8809395–		(Workshop on development of advanced technology for scientific research; Kumatori (Japan); 12-13 Sep 1988)			
	14:47240	*See* KURRI-TR–310			
CONF-8810105–		(8. annual EPRI conference on coal gasification; Palo Alto, CA (USA); 19-20 Oct 1988)			
	14:46823	*See* EPRI-GS–6485			
CONF-881011–		(Joint meeting of the European Nuclear Society and the American Nuclear Society; Washington, DC (USA); 30 Oct - 4 nov 1988)			
	14:47167				
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Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
	14:47193				
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	14:47196				
	14:47197				
CONF-8810120–		(Society of Automotive Engineers fuels and lubricants meeting and exposition; Portland, OR (USA); 10-13 Oct 1988)			
	14:47021	Society of Automotive Engineers, 400 Commonwealth Dr., Warrendale, PA 15096			
	14:47028	Society of Automotive Engineers, 400 Commonwealth Dr., Warrendale, PA 15096			
	14:47308	Society of Automotive Engineers, 400 Commonwealth Dr., Warrendale, PA 15096			
	14:47309	Society of Automotive Engineers, 400 Commonwealth Dr., Warrendale, PA 15096			
	14:47310	Society of Automotive Engineers, 400 Commonwealth Dr., Warrendale, PA 15096			
	14:47311	Society of Automotive Engineers, 400 Commonwealth Dr., Warrendale, PA 15096			
CONF-8811171–		(17. INS international symposium on nuclear physics at intermediate energies; Tokyo (Japan); 15-17 Nov 1988)			
5	14:48295	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017802/JAW	MF-414
CONF-8811181–		(4. international workshop on cross sections for fusion and other applications; College Station, TX (USA); 2-5 Nov 1988)			
	14:48281				
CONF-881151–		(10. international conference on the application of accelerators in research and industry; Denton, TX (USA); 7-9 Nov 1988)			
	14:47459				
	14:47480				
	14:48359				
	14:48527				
	14:48528				
CONF-881154–		(International symposium on electron beam ion sources and their applications; Upton, NY (USA); 14-18 Nov 1988)			
9	14:47803	*See* BNL–42997			
CONF-881190–		(3. Japan-US workshop on tritium radiobiology and health physics; Kyoto (Japan); 8-10 Nov 1988)			
4	14:48121	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89015373/JAW	MF-408
CONF-890103–		(6. symposium on space nuclear power systems; Albuquerque, NM (USA); 9-12 Jan 1989)			
11	14:47351	*See* DOE/NASA/16310–11			
CONF-8901161–		(2. international symposium on new trends in chemistry: the role of analytical chemistry in national development; Le Caire (Egypt); 2-7 Jan 1989)			
	14:48100	*See* CEA-CONF–9774			
CONF-890199–		(24. Rencontre de Moriond on tests of fundamental laws in physics; Les Arcs (France); 21-28 Jan 1989)			
6	14:47823	*See* DOE/ER/40048–221-LP			
7	14:48437	*See* DOE/ER/40048–222-L9			
CONF-8902117–		(Symposium on physical metallurgy of controlled expansion invar-type alloys; Las Vegas, NV (USA); 28 Feb 1989)			
2	14:48176	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017581/JAW	MF-404; MF-411
CONF-8902118–		(International Energy Agency workshop on fusion materials irradiation facilities; San Diego, CA (USA); 14-17 Feb 1989)			
3	14:48669	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017574/JAW	MF-423
CONF-8902124–		(18. annual symposium on applied vacuum science and technology; Clearwater Beach, FL (USA); 6-8 Feb 1989)			
	14:47439	*See* N–89-21104			
CONF-8902130–		(17. AINSE plasma physics conference; Lucas Heights (Australia); 6-8 Feb 1989)			
	14:48581	*See* INIS-mf–11537			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-8902132–		(25. Karpacz winter school of theoretical physics; Karpacz (Poland); 20 Feb - 5 mar 1989)			
1	14:48385	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE90000006/JAW	MF-414
CONF-8903131–		(Chapman conference on the physics of magnetic flux ropes; Hamilton (Bermuda); 27-31 Mar 1989)			
3	14:48240	*See* LA-UR–89-2529			
CONF-8903160–		(Kirchberg workshop on electronic properties of polymers and related compounds; Boston, MA (USA); Mar 1989)			
1	14:47431	*See* LA-UR–89-2806			
CONF-890335–		(13. particle accelerator conference; Chicago, IL (USA); 20-23 Mar 1989)			
251	14:47800	*See* BNL–42004			
253	14:47799	*See* BNL–41891			
CONF-890352–		(US Department of Energy research and development for the geothermal marketplace: 7th geothermal program review; San Francisco, CA (USA); 21-23 Mar 1989)			
	14:47051	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015627/JAW	MF-250
CONF-890353–		(6. annual coal-fueled heat engines and gas stream cleanup systems contractors review meeting; Morgantown, WV (USA); 21-23 Mar 1989)			
	14:46879	*See* DOE/METC–89/6101			
CONF-890372–		(4. hypercube, concurrent computers and applications; Monterey, CA (USA); 6-8 Mar 1989)			
	14:48732	*See* N–89-20684			
	14:48733	*See* N–89-20685			
CONF-890379–		(Workshop on calorimetry for the SSC; Tuscaloosa, AL (USA); 13-17 Mar 1989)			
14	14:48290	*See* BNL–43150			
15	14:48291	*See* BNL–43151			
CONF-890398–		(DOE/LLNL symposium on explosion-source phenomenology; Lake Tahoe, CA (USA); 14-16 Mar 1989)			
	14:47915	NTIS, PC A12/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016501/JAW	MF-741
CONF-8904112–		(30. structures, structural dynamics and materials conference; Mobile, AL (USA); 3-5 Apr 1989)			
	14:47436	*See* N–89-20206			
CONF-8904133–		(Symposium on geochemistry of sulfur in fossil fuels; Dallas, TX (USA); 9-14 Apr 1989)			
1	14:46832	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016895/JAW	MF-401
CONF-8904153–		(Symposium on nuclear dynamics and nuclear disassembly; Dallas, TX (USA); 9-14 Apr 1989)			
5	14:48460	*See* UCRL–101297			
CONF-8904201–		(American Nuclear Society meeting; Gaithersburg, MD (USA); 25-28 Apr 1989)			
4	14:47008	*See* LA-UR–89-1347			
CONF-890421–		(91. annual meeting of the American Ceramic Society; Indianapolis, IN (USA); 23-27 Apr 1989)			
11	14:46980	*See* PNL-SA–16832			
CONF-8904266–		(Conference on comets in Post-Halley area; Bamberg (Germany, F.R.); 24-28 Apr 1989)			
1	14:48182	*See* KFKI–1989-36/C			
CONF-8904267–		(Symposium on particle identification at high luminosity hadron colliders; Batavia, IL (USA); 5-7 Apr 1989)			
1	14:47825	*See* FNAL/C–89/170-E			
CONF-890446–		(Combustion Institute spring meeting: combustion fundamentals and applications; Dearborn, MI (USA); 30 Apr - 3 may 1989)			
	14:46903	*See* N–89-21051			
CONF-890454–		(2. international conference on high-density plasmas; Laguna Beach, CA (USA); 24-28 Apr 1989)			
1	14:48656	*See* LA-UR–89-2710			
CONF-890492–		(Natural gas research and development; Morgantown, WV (USA); 18-19 Apr 1989)			
3	14:47019	*See* UCRL–100943			
CONF-8905126–		(Workshop on cold fusion phenomena; Santa Fe, NM (USA); 23-25 May 1989)			
Summs.	14:48582	*See* LA–11686-C			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-8905141–		(5. international conference on electrostatic accelerators and associated boosters; Strasbourg (France); 24-27 May 1989)			
4	14:47806	*See* DOE/ER/40048–231-L9			
CONF-8905143–		(NATO advanced study institute international advanced course on the nuclear equation of state; Peniscola (Spain); 12 May - 3 jun 1989)			
14	14:48473	*See* LA-UR–89-2744			
15	14:48293	*See* BNL–43184			
CONF-8905152–		(NIST and NRC workshop on cement solidification of low level radioactive waste; Gaithersburg, MD (USA); 31 May - 12 jun 1989)			
2	14:46965	*See* EGG-M–89245			
CONF-8905187–		(WEIN '89: international symposium on weak and electromagnetic interactions in nuclei; Montreal (Canada); 15-19 May 1989)			
2	14:48357	*See* SLAC-PUB–5057			
3	14:48484	*See* UCRL–100547			
CONF-890519–		(5. international symposium on graphite intercalation compounds; Berlin (Germany, F.R.); 22-25 May 1989)			
1	14:48496	*See* BNL–42810			
CONF-8905193–		(Workshop on physics and experimental techniques of high energy neutrinos and VHE and UHE gamma-ray particle astrophysics; Little Rock, AR (USA); 11-13 May 1989)			
2	14:48183	*See* LA-UR–89-2482			
CONF-8905197–		(4. Princeton liposome conference; Princeton, NJ (USA); 15-16 May 1989)			
1	14:48101	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89015352/JAW	MF-408
CONF-8905199–		(State of Mississippi energy future symposium; Jackson, MS (USA); 21-24 May 1989)			
2	14:47030	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016288/JAW	MF-249
CONF-890520–		(International conference: inside the sun; Versailles (France); 22-26 May 1989)			
2	14:48318	*See* LA-UR–89-2779			
CONF-8905203–		(Workshop on the management of radioactively contaminated sites; Albuquerque, NM (USA); 3-5 May 1989)			
1	14:47003	*See* EGG-M–89176			
CONF-8905210–		(International conference on synchrotron radiation application; Hefei (China); 9-12 May 1989)			
1	14:47781	*See* BNL–43105			
2	14:47780	*See* BNL–42946			
CONF-890532–		(Topical meeting on tunable solid state lasers; North Falmouth, MA (USA); 1-3 May 1989)			
1-Rev.1	14:47748	*See* UCRL–100862-Rev.1			
CONF-890552–		(34. international symposium and exhibition of the Society for the Advancement of Material and Process Engineering (SAMPE); Reno, NV (USA); 8-11 May 1989)			
	14:47033	*See* N–89-21100			
CONF-890601–		(Packaging and transportation of radioactive materials: PATRAM '89; Arlington, VA (USA); 11-16 Jun 1989)			
2	14:47729	*See* UCRL–101777			
CONF-890604–		(Annual meeting of the American Nuclear Society; Atlanta, GA (USA); 4-8 Jun 1989)			
16	14:47134	*See* DOE/SSDP–0074			
17	14:47001	*See* DOE/SSDP–0073			
18	14:47002	*See* DOE/SSDP–O070			
19	14:47000	*See* DOE/SSDP–0067			
CONF-8906161–		(Ion beam analysis conference; Kingston (Canada); 26-30 Jun 1989)			
6	14:47461	*See* BNL–43048			
CONF-8906169–		(International Astronautics Federation conference on space power; Cleveland, OH (USA); 5-7 Jun 1989)			
	14:47203	*See* N–89-21419			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-8906181–		(International Thermonuclear Experimental Reactor (ITER) specialist meeting on electromagnetics; Garching (Germany, F.R.); 22 Jun 1989)			
2	14:47136	*See* EGG-M–89091			
CONF-8906186–		(Materials Research Society materials analysis workshop; Albuquerque, NM (USA); 14-17 Jun 1989)			
5	14:48474	*See* LA-UR–89-2788			
CONF-8906200–		(Large area electron beam diode workshop; Monterey, CA (USA); 7 Jun 1989)			
1	14:47448	*See* SAND–89-1829C			
CONF-8906201–		(Workshop on theoretical geoplasma physics; Cambridge, MA (USA); Jun 1989)			
1	14:48241	*See* LA-UR–89-2740			
2	14:48242	*See* LA-UR–89-2746			
CONF-8906203–		(International symposium on platelet-vessel wall interaction; Lubeck (Germany, F.R.); 8-9 Jun 1989)			
1	14:48102	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89015375/JAW	MF-408
CONF-8906204–		(International symposium on heavy quark physics; Ithaca, NY (USA); 13-17 Jun 1989)			
3	14:48323	*See* ANL-HEP-CP–89-80			
CONF-8906205–		(NATO advanced study institute on lower-dimensional systems and molecular electronics; Spetses (Greece); 12-23 Jun 1989)			
1	14:47347	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016912/JAW	MF-401
CONF-8906206–		(5. IAP astrophysics meeting on astrophysical ages and dating methods; Paris (France); 26-29 Jun 1989)			
1	14:48185	*See* LA-UR–89-2961			
2	14:48186	*See* LA-UR–89-2962			
CONF-8906207–		(Symposium on ferroelectric liquid crystals; Goteborg (Sweden); 27-30 Jun 1989)			
1	14:47432	*See* LA-UR–89-2840			
CONF-8906208–		(International workshop on physics and techniques of high power opening switches; Novosibirsk (USSR); 30 Jun - 2 jul 1989)			
1	14:48691	*See* SAND–89-0283C			
CONF-8906210–		(Workshop on B-factories and related issues; Blois (France); 26 Jun - 1 jul 1989)			
1	14:48320	*See* SLAC-PUB–5047			
2	14:48324	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017692/JAW	MF-414
CONF-890628–		(30. US symposium on rock mechanics; Morgantown, WV (USA); 19-22 Jun 1989)			
7	14:46983	*See* SAND–88-2744			
CONF-890644–		(Society of Petroleum Engineers gas technology symposium: gas technology serving a competitive market; Dallas, TX (USA); 7-9 Jun 1989)			
1	14:47018	*See* UCRL–100768			
CONF-890665–		(7. Institute of Electrical and Electronics Engineers pulsed power conference; Monterey, CA (USA); 12-14 Jun 1989)			
44	14:48690	*See* SAND–89-0139C			
45	14:47767	*See* SAND–89-1954C			
46	14:47201	*See* LA-UR–89-2877			
47	14:47802	*See* BNL–42996			
48-Rev.1	14:47727	*See* UCRL–100357-Rev.1			
CONF-890666–		(Gasification and gas stream cleanup systems; Morgantown, WV (USA); 27-30 Jun 1989)			
3	14:46792	*See* BNL–42836			
CONF-890686–		(International conference on new aspects of nuclear spectroscopy; Crete (Greece); 26-30 Jun 1989)			
1	14:48457	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017770/JAW	MF-413
CONF-890692–		(82. Air and Waste Management Association annual meeting and exhibition; Anaheim, CA (USA); 25-30 Jun 1989)			
20	14:47923	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017255/JAW	MF-402
CONF-890697–		(NATO Advanced Study Institute on non-equilibrium processes in partially ionized gases; Acquafredda di Maratea (Italy); 4-17 Jun 1989)			
3	14:48278	*See* UCRL–101228			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-890701–		(International cryogenic materials conference; Los Angeles, CA (USA); 24-28 Jul 1989)			
3	14:47352	*See* FNAL-TM–1613			
4	14:48695	*See* UCRL–100530			
5	14:47726	*See* UCRL–100270			
CONF-890703–		(International conference on ion sources; Berkeley, CA (USA); 9-15 Jul 1989)			
17	14:47805	*See* DOE/ER/40048–227-L9			
18	14:48668	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017586/JAW	MF-420
CONF-890708–		(16. international conference on the physics of electronic and atomic collisions; New York, NY (USA); 26 Jul - 1 aug 1989)			
7	14:48244	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017579/JAW	MF-411
CONF-890710–		(5. international conference on megagauss magnetic field generation and related topics; Novosibirsk (USSR); 3-7 Jul 1989)			
17	14:47766	*See* LA-UR–89-2921			
18	14:47768	*See* UCRL–100642			
CONF-8907103–		(Technology-based confidence building: energy and environment; Santa Fe, NM (USA); 9-14 Jul 1989)			
4	14:46969	*See* LA-UR–89-2630			
5	14:47925	*See* LA-UR–89-2858			
6	14:47247	*See* LA-UR–89-2713			
7	14:47919	*See* LA-UR–89-2964			
CONF-8907106–		(Institute of Mathematics and its applications: conference on computational ordinary differential equations; London (UK); 3-7 Jul 1989)			
3	14:48724	*See* DOE/ER/25026–32			
CONF-890711–		(5. international conference on emerging nuclear energy systems: ICENES '89; Karlsruhe (Germany, F.R.); 3-6 Jul 1989)			
3	14:48667	*See* BNL–43062			
CONF-8907113–		(5. international conference on environmental mutagens; Cleveland, OH (USA); 10-15 Jul 1989)			
7	14:48094	*See* UCRL–101588			
CONF-8907123–		(EPA waste testing and quality assurance symposium; Washington, DC (USA); 24-28 Jul 1989)			
2	14:48742	*See* EGG-M–89040			
CONF-8907130–		(9. vacuum ultraviolet radiation conference; Honolulu, HI (USA); 17-21 Jul 1989)			
2	14:48531	*See* LA-UR–89-2680			
CONF-8907133–		(6. international conference on hot carriers in semiconductors; Scottsdale, AZ (USA); 23-28 Jul 1989)			
1	14:48523	*See* SAND–89-1875C			
CONF-8907135–		(International conference on the physics of electronic and atomic collisions (ICPEAC); New Haven, CT (USA); 23-25 Jul 1989)			
1	14:48272	*See* LA-UR–89-2506			
CONF-8907137–		(Symposium on plant life extension for nuclear components; Honolulu, HI (USA); 24-27 Jul 1989)			
1	14:47084	NTIS, PC A03/MF A01; OSTI, INIS; GPO Dep.	E 1.99:	DE89016906/JAW	
CONF-8907138–		(4. Adriatico research conference (AARC '89) on quasicrystals; Trieste (Italy); 4-7 Jul 1989)			
1	14:47418	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016909/JAW	MF-401
CONF-8907139–		(International School of Materials Science and Technology: earlier and recent aspects of superconductivity; Erice (Italy); 4-16 Jul 1989)			
1	14:48532	*See* LA-UR–89-2885			
CONF-8907140–		(18. international conference on differential geometric methods in theoretical physics: physics and geometry; Tahoe City, CA (USA); 2-8 Jul 1989)			
1	14:48418	*See* SLAC-PUB–5031			
CONF-8907144–		(Summer symposium on synchrotron orbital radiation and heavy ion accelerator science; Seoul (Republic of Korea); 4-6 Jul 1989)			
1	14:47790	*See* BNL–42990			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-890718–		(International conference on materials and mechanisms of superconductivity - high-temperature superconductors; Stanford, CA (USA); 23-28 Jul 1989)			
26	14:48535	*See* UCRL–100695			
28	14:47405	*See* UCRL–100094			
CONF-890721–		(Joint ASME/JSME pressure vessel and piping conference; Honolulu, HI (USA); 23-27 Jul 1989)			
39	14:47131	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016902/JAW	MF-530
40	14:47132	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016903/JAW	MF-530
42	14:47099	NTIS, PC A03/MF A01; OSTI; INIS		DE89016910/JAW	MF-530
CONF-890736–		(30. annual meeting of the Institute of Nuclear Materials Management; Orlando, FL (USA); 9-12 Jul 1989)			
66	14:47472	*See* DP-MS–89-33			
68	14:47006	*See* DP-MS–89-46			
CONF-890741–		(ASME international computers in engineering conference; Anaheim, CA (USA); 30 Jul - 2 aug 1989)			
2	14:47133	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016911/JAW	MF-530
CONF-890756–		(17. international symposium on shock waves and shock tubes (STS-17); Bethlehem, PA (USA); 17-21 Jul 1989)			
2	14:47482	*See* BNL–42981			
CONF-890781–		(IEEE summer power meeting; Long Beach, CA (USA); 9-14 Jul 1989)			
3	14:47716	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016858/JAW	MF-223
CONF-890796–		(International workshop on high power opening switches; Novosibirsk (USSR); 1-2 Jul 1989)			
3	14:48692	*See* SAND–89-1270C			
CONF-890798–		(AIRAPT and EHPRG international high pressure science and technology conference; Paderborn (Germany, F.R.); 17-21 Jul 1989)			
11	14:48227	*See* UCRL–101436			
CONF-890803–		(International conference on high energy accelerators; Tsukuba (Japan); 20-26 Aug 1989)			
12	14:47783	*See* FNAL/C–89/182			
13	14:47791	*See* BNL–43175			
16	14:47792	*See* BNL–43204			
CONF-890809–		(9. international conference on vacuum ultraviolet radiation physics; Honolulu, HI (USA); 14-18 Aug 1989)			
1	14:47838	*See* UCRL–100784			
CONF-890811–		(9. international symposium on detonation; Portland, OR (USA); 28 Aug - 1 sep 1989)			
28	14:47858	*See* LA-UR–89-2898			
29	14:47864	*See* UCRL–101617			
30	14:47865	*See* UCRL–101680			
CONF-890812–		(American Physical Society topical conference on shock compression of condensed matter; Albuquerque, NM (USA); 14-17 Aug 1989)			
11	14:47444	*See* SAND–88-3338C			
22	14:48161	*See* LA-UR–89-2664			
23	14:48519	*See* LA-UR–89-2718			
24	14:47370	*See* LA-UR–89-2869			
25	14:48164	*See* SAND–89-1019C			
26	14:47445	*See* SAND–89-0661C			
28	14:47404	*See* SAND–89-1115C			
29	14:47433	*See* LA-UR–89-2864			
33	14:48287	*See* LA-UR–89-2717			
35	14:47861	*See* SAND–89-1069C			
40	14:47856	*See* LA-UR–89-2773			
41	14:47725	*See* SAND–89-1964C			
42	14:48524	*See* UCRL–100804			
43	14:47863	*See* UCRL–100835			
44	14:48696	*See* UCRL–101646			
45	14:48525	*See* UCRL–101616			
CONF-8908127–		(3. international seminar on containment of nuclear reactors; Los Angeles, CA (USA); 10-11 Aug 1989)			
1	14:47151	*See* SAND–89-1854C			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
2	14:47152	*See* SAND–89-1878C			
CONF-8908131–		(2. LAMPF workshop on pion-nucleus double charge exchange; Los Alamos, NM (USA); 9-11 Aug 1989)			
1	14:48475	*See* LA-UR–89-2981			
CONF-8908132–		(11. quartz devices conference; Kansas City, MO (USA); 28-31 Aug 1989)			
1	14:47446	*See* SAND–89-0814C			
CONF-8908133–		(24. Yamada conference on strongly coupled plasma physics; Tokyo (Japan); 29 Aug - 2 sep 1989)			
2	14:48228	*See* UCRL–101753			
CONF-8908134–		(11. international free electron laser conference; Naples, FL (USA); 28 Aug - 1 sep 1989)			
1	14:47786	*See* LA-UR–89-2894			
2	14:47743	*See* LA-UR–89-2867			
4	14:47744	*See* LA-UR–89-2915			
CONF-8908137–		(5. annual conference of the Society for Applied Learning Technology on applications of artificial intelligence and CD-ROM in education and training; Arlington, VA (USA); 23-25 Aug 1989)			
1	14:48721	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016856/JAW	MF-406
2	14:48722	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016861/JAW	MF-406
CONF-890814–		(American Institute of Chemical Engineer's summer national meeting; Philadelphia, PA (USA); 20-23 Aug 1989)			
4	14:48706	*See* PNL-SA–17193			
5	14:47294	*See* PNL-SA–17246			
CONF-8908140–		(SPIE conference on high speed photography, videography, and photonics; San Diego, CA (USA); 8 Aug 1989)			
1	14:47846	*See* LA-UR–89-2657			
CONF-8908141–		(U.S. Department of Energy conference on technology research and development for arms control verification; Los Alamos, NM (USA); 29-31 Aug 1989)			
1	14:47916	*See* SAND–89-2121C			
2	14:47322	*See* K/ITP–290			
3	14:47917	*See* UCRL–101542			
CONF-8908142–		(14. international symposium on lepton and photon interactions; Stanford, CA (USA); 7-12 Aug 1989)			
1	14:48321	*See* SLAC-PUB–5052			
CONF-890815–		(24. intersociety energy conversion engineering conference; Arlington, VA (USA); 6-11 Aug 1989)			
15	14:47752	*See* LA-UR–89-1584			
22	14:47285	*See* EGG-M–88520			
25	14:47101	*See* PNL-SA–17011			
26	14:47261	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017689/JAW	MF-330
27	14:47078	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017681/JAW	MF-105
CONF-890821–		(13. international conference on atomic collisions in solids; Aarhus (Denmark); 7-11 Aug 1989)			
3	14:48497	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017677/JAW	MF-404
CONF-890826–		(International nuclear physics conference; Sao Paulo (Brazil); 20-26 Aug 1989)			
3	14:48458	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017583/JAW	MF-413
CONF-890836–		(33. SPIE annual international technical symposium on optical and optoelectronic applied science and engineering; San Diego, CA (USA); 6-11 Aug 1989)			
10	14:48273	*See* LA-UR–89-2620			
11	14:48271	*See* LA-UR–89-2500			
12	14:47719	*See* LA-UR–89-2671			
13	14:47728	*See* UCRL–100403			
14	14:47850	*See* UCRL–101721			
CONF-890841–		(International workshop on safety of nuclear installations of the next generation and beyond; Chicago, IL (USA); 28-31 Aug 1989)			
1	14:47114	*See* GA-A–19823			
CONF-890854–		(11. annual DOE low level waste management conference; Pittsburgh, PA (USA); 22-24 Aug 1989)			
10	14:46979	*See* PNL-SA–16788			
11	14:46982	*See* PNL-SA–16884			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
12	14:46958	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016873/JAW	MF-721
CONF-890867–		(6. international symposium on water-rock interaction; Malvern (UK); 3-9 Aug 1989)			
2	14:46981	*See* PNL-SA–16877			
CONF-890901–		(14. world energy conference; Montreal (Canada); 17-22 Sep 1989)			
	14:47254	*See* SOQUIP–1988			
CONF-890906–		(11. international vacuum congress and 7th international conference on solid surfaces; Cologne (Germany, F.R.); 25-29 Sep 1989)			
1	14:47804	*See* BNL–43100			
2	14:47801	*See* BNL–42699			
CONF-890911–		(International conference on operability of nuclear systems in normal and adverse environments; Lyon (France); 18-22 Sep 1989)			
3	14:47088	*See* SAND–88-1881C			
CONF-8909110–		(16. annual conference of the American Society for Quality Control; Fort Lauderdale, FL (USA); 17-20 Sep 1989)			
4	14:47005	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89014081/JAW	MF-721
CONF-8909113–		(14. international pyrotechnics seminar; Jersey (UK); 18-22 Sep 1989)			
4	14:47860	*See* SAND–89-0344C			
CONF-8909124–		(International conference on lightning and static electricity; Bath (UK); 26-28 Sep 1989)			
4	14:47769	*See* UCRL–101192			
CONF-8909181–		(Electric and hybrid vehicle contractors' meeting; Idaho Falls, ID (USA); 6-8 Sep 1989)			
1	14:47207	*See* SAND–89-2136C			
CONF-8909182–		(NATO advanced study institute on chemistry and physics of molecular processes in energetic materials; Sicily (Italy); 2-15 Sep 1989)			
1	14:47857	*See* LA-UR–89-2783			
2	14:47859	*See* LA-UR–89-2936			
CONF-8909184–		(IAEA specialists meeting on superconducting materials and magnets; Tokyo (Japan); 4-6 Sep 1989)			
1	14:48670	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016867/JAW	MF-423
CONF-8909185–		(16. symposium on gallium arsenide and related compounds; Karuizawa (Japan); 25-29 Sep 1989)			
1	14:47447	*See* SAND–89-1116C			
CONF-8909186–		(8. annual conference of the Apollo Domain User's Society; New Orleans, LA (USA); 10-13 Sep 1989)			
1	14:48728	*See* LA-UR–89-2828			
CONF-8909187–		(PATRAN users conference; Costa Mesa, CA (USA); 6-8 Sep 1989)			
1	14:47753	*See* LA-UR–89-2661			
2	14:48727	*See* LA-UR–89-2660			
CONF-8909194–		(Annual convention of the Austrian physical society; Linz (Austria); 25-29 Sep 1989)			
	14:48172	*See* INIS-mf–11515			
CONF-890923–		(World congress of the International Solar Energy Society; Kobe (Japan); 4-8 Sep 1989)			
1	14:47040	*See* SAND–89-2009C			
CONF-890928–		(Nuclear waste isolation in the unsaturated zone: FOCUS '89; Las Vegas, NV (USA); 18-21 Sep 1989)			
3	14:46970	*See* LA-UR–89-2952			
CONF-890931–		(13. conference on the numerical simulation of plasmas; Santa Fe, NM (USA); 17-20 Sep 1989)			
4	14:48184	*See* LA-UR–89-2686			
5	14:48655	*See* LA-UR–89-2687			
6	14:48578	*See* UCRL–101396			
7	14:48663	*See* UCRL–101395			
8	14:48662	*See* UCRL–101322			
CONF-890933–		(International conference on the applications of the Mossbauer effect (ICAME '89); Budapest (Hungary); 4-8 Sep 1989)			
1	14:48518	*See* LA-UR–89-2324			
2	14:47331	*See* BNL–43052			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
CONF-890946–		(3. meeting on defect recognition and image processing in semiconductors (DRIP-3); Yokohama (Japan); 17-22 Sep 1989)			
1	14:48522	*See* SAND–88-3307C			
CONF-890953–		(International conference on the physics of highly correlated electron systems; Santa Fe, NM (USA); 11-15 Sep 1989)			
2	14:47330	*See* BNL–42866			
CONF-890978–		(21. Europhysics conference on macromolecular physics: electrical and optical active polymers; Lodz (Poland); 4-8 Sep 1989)			
1	14:47430	*See* LA-UR–89-2685			
CSIR-RR–					
599	14:48492	the National Accelerator Centre, Council for Scientific and Industrial Research, PO Box 72, Faure, 7131, South Africa			
CSIR-SR-ELEK–					
308	14:47315	*See* PB–89-169510/XAB			
CTN–					
89-005	14:48749	*See* UCID–21680			
89-007	14:48748	*See* UCID–21679			
89-011	14:48707	*See* UCID–21684			
89-013	14:48750	*See* UCID–21765			
DFVLR-FB–					
89-16	14:48141	NTIS (US Sales Only), PC A08/MF A01		DE90702748/JAW	
DLG–					
538030	14:48122	NTIS (US Sales Only), PC A03/MF A01		DE90702760/JAW	
DLR-FB–					
89-33	14:47348	NTIS (US Sales Only), PC A06/MF A01		DE90702783/JAW	
89-35	14:47017	NTIS (US Sales Only), PC A07/MF A01		DE90702784/JAW	
DOE-RW–					
87.113	14:46964	NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS		DE90601725/JAW	
88.103	14:47991	NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS		DE90601353/JAW	
89.017	14:47959	*See* AERE-R–12362			
DOE/BP–					
972	14:47080	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017648/JAW	MF-920
DOE/BP/64849–					
1	14:47282	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017655/JAW	MF-920; MF-906
DOE/CE–					
0267	14:47264	NTIS, PC A19/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016794/JAW	MF-350
DOE/CE/10509–					
H1	14:47236	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016063/JAW	MF-310; MF-350
DOE/CE/15290–					
T1	14:47717	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016795/JAW	MF-202
DOE/CE/15401–					
T4	14:47843	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89014439/JAW	MF-310
DOE/CE/15412–					
T1	14:47349	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016437/JAW	MF-366
DOE/CE/26576–					
T2	14:47296	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017265/JAW	MF-350
DOE/CE/30806–					
T3	14:47265	NTIS, PC A08/MF A01 - OSTI		DE89016009/JAW	MF-232
DOE/CE/40740–					
T4	14:47283	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016404/JAW	PC-310; PC-310
DOE/CH/00016–					
H2	14:47237	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016923/JAW	MF-350
DOE/DP/10618–					
T2	14:48671	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017558/JAW	MF-712
DOE/EIA–					
0478(88)	14:46925	NTIS, PC A06/MF A01 - GPO; OSTI; INIS; GPO Dep.	E 1.99:	DE89017709/JAW	MF-950
DOE/ER–					
0144/7	14:47238	NTIS, PC A07/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89010902/JAW	PC-400; PC-401; PC-400; PC-401

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
0422	14:48723	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016694/JAW	PC-405
0423	14:48740	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016695/JAW	MF-405
DOE/ER/01195–					
T11	14:48296	NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017447/JAW	MF-414
T12	14:48297	NTIS, PC A08/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017448/JAW	MF-414
DOE/ER/03065–					
54	14:48289	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016743/JAW	MF-414
DOE/ER/13329–					
3	14:47718	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017513/JAW	MF-401
DOE/ER/13592–					
4	14:47539	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017637/JAW	MF-401
DOE/ER/13615–					
3	14:47024	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017813/JAW	MF-401
DOE/ER/13616–					
3	14:46814	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017423/JAW	MF-401
DOE/ER/13625–					
3	14:47025	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017421/JAW	MF-401
DOE/ER/13664–					
3	14:47483	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017268/JAW	MF-401
DOE/ER/13781–					
2	14:47484	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017317/JAW	MF-401
DOE/ER/13821–					
2	14:48498	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017809/JAW	MF-411
DOE/ER/13834–					
7	14:47350	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017807/JAW	MF-411
DOE/ER/13973–					
1	14:47741	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017442/JAW	MF-406
DOE/ER/25019–					
11	14:47742	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017270/JAW	MF-405
DOE/ER/25026–					
32	14:48724	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017329/JAW	MF-405
33	14:48725	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017328/JAW	MF-405
DOE/ER/25061–					
1	14:48284	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017380/JAW	MF-405
DOE/ER/40020–					
T4	14:48429	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89015517/JAW	MF-413
DOE/ER/40048–					
221-LP	14:47823	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017312/JAW	MF-413
222-L9	14:48437	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017311/JAW	MF-413
224-L9	14:48465	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017319/JAW	MF-413
226-L9	14:48430	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017274/JAW	MF-413
227-L9	14:47805	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017313/JAW	MF-413
231-L9	14:47806	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017269/JAW	MF-414
DOE/ER/40215–					
T9	14:48325	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017788/JAW	MF-414
DOE/ER/40256–					
4	14:48245	NTIS, PC A08/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017357/JAW	MF-414
DOE/ER/40310–					
3	14:47824	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017358/JAW	MF-413
DOE/ER/40322–					
075	14:48466	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017806/JAW	MF-413
DOE/ER/40399–					
2	14:48298	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017362/JAW	MF-413
DOE/ER/45140–					
T1	14:47419	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016554/JAW	MF-404
DOE/ER/45163–					
12	14:47471	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017271/JAW	MF-404
DOE/ER/45274–					
3	14:47420	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016469/JAW	MF-404
DOE/ER/52122–					
4	14:48672	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017314/JAW	MF-421
DOE/ER/53218–					
11	14:48585	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017401/JAW	MF-421
DOE/ER/60242–					
T1	14:47972	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016544/JAW	MF-402
T2	14:47973	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016600/JAW	MF-402
DOE/ER/60305–					
T1	14:48086	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015548/JAW	MF-408
DOE/ER/60638–					
1	14:48087	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016560/JAW	MF-408

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
DOE/ER/72012–					
T8	14:48285	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017554/JAW	MF-405
DOE/FE–					
0116-2	14:47252	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016713/JAW	MF-126
DOE/ID/12467–					
3	14:47485	NTIS, PC A09/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015201/JAW	PC-313; PC-313
DOE/ID/12693–					
3	14:47057	NTIS, PC A17/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017552/JAW	MF-257
DOE/IG–					
0271	14:47210	OSTI		TI89016693/JAW	PC-960
DOE/MC/20422–					
2729	14:46905	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89011682/JAW	PC-132; PC-132
DOE/MC/21023–					
2716	14:47074	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89011670/JAW	PC-103; PC-103
DOE/MC/22012–					
2726	14:47284	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89011689/JAW	PC-110; PC-110
DOE/MC/22137–					
2704-Vol.1	14:46815	NTIS, PC A17/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89000990/JAW	PC-109; PC-115; PC-109; PC-115
DOE/MC/22181–					
2694	14:47305	NTIS, PC A08/MF A01 - OSTI		DE89000984/JAW	PC-111; PC-111
DOE/MC/23251–					
2730	14:46840	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89011700/JAW	PC-106; PC-106
DOE/MC/23277–					
2731	14:46816	NTIS, PC A10/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89011675/JAW	PC-109; PC-109
DOE/MC/23288–					
2697	14:46817	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89000987/JAW	PC-109
DOE/MC/24092–					
2725	14:46923	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89011694/JAW	MF-123
DOE/METC–					
89/6101	14:46879	NTIS, PC A23/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89000952/JAW	MF-106
DOE/NASA/16310–					
10	14:47421	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017744/JAW	PC-504
11	14:47351	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017743/JAW	PC-504
DOE/OR/21400–					
T392	14:47985	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017325/JAW	MF-402
T394	14:47246	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017333/JAW	MF-500
DOE/OSTI–					
4500-Rev.75	14:48741	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89005395/JAW	MF-2; PC-2
DOE/PC/70018–					
68	14:46818	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016731/JAW	MF-108
DOE/PC/79680–					
T1	14:47257	NTIS, PC A04/MF A01 - OSTI		DE89015600/JAW	MF-112
DOE/PC/79881–					
T1	14:46790	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016048/JAW	PC-102; PC-102
DOE/PC/80502–					
T14	14:46898	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016748/JAW	MF-108
DOE/PC/80908–					
12	14:46819	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016756/JAW	MF-108
DOE/PC/80910–					
T6	14:46820	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015994/JAW	PC-108; PC-108
DOE/PC/88818–					
2	14:46821	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017801/JAW	MF-108
DOE/PC/88912–					
T2	14:46833	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017641/JAW	MF-104
DOE/PC/90274–					
T5	14:47258	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90001081/JAW	MF-112
DOE/PC/90517–					
T3	14:46845	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015594/JAW	PC-114; PC-114

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
DOE/PC/90529–					
10	14:46822	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017519/JAW	MF-109
DOE/PETC/QTR–					
88/3	14:46791	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89013433/JAW	PC-108; MF-108; PC-102; MF-102;
DOE/RL–					
89-21	14:46929	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017226/JAW	MF-500
89-22	14:46985	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017341/JAW	MF-532
DOE/SF/15754–					
T1	14:47047	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015608/JAW	MF-231
DOE/SSDP–					
0067	14:47000	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016830/JAW	MF-511
0073	14:47001	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016835/JAW	MF-511
0074	14:47134	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016834/JAW	MF-511
O070	14:47002	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016836/JAW	MF-511
DP-MS–					
89-33	14:47472	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017853/JAW	MF-705
89-46	14:47006	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017855/JAW	MF-705
DPST–					
88-1004	14:47122	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017844/JAW	MF-706
E–					
4385	14:47440	*See* N–89-21256			
4426	14:48731	*See* N–89-20641			
4468	14:47774	*See* N–89-20135			
4500	14:47543	*See* N–89-21103			
4550-1	14:47043	*See* N–89-19493			
4577	14:48575	*See* N–89-20710			
4594	14:47044	*See* N–89-21174			
4610	14:47436	*See* N–89-20206			
4627	14:47263	*See* N–89-20545			
4647	14:48733	*See* N–89-20685			
4649	14:47033	*See* N–89-21100			
4652	14:48732	*See* N–89-20684			
4662	14:47396	*See* N–89-20252			
4671	14:47439	*See* N–89-21104			
4673	14:47754	*See* N–89-21025			
4675	14:46903	*See* N–89-21051			
4679	14:47203	*See* N–89-21419			
EA-THA–					
51E5-VOL-2	14:48017	*See* AD-A–206276/8/XAB			
ECN–					
217	14:47067	Netherlands Energy Research Foundation ECN, P.O. Box 1, 1755 ZG Petten, Netherlands			
218	14:47068	Netherlands Energy Research Foundation ECN, P.O. Box 1, 1755 ZG Petten, Netherlands			
ECTB–					
154-11A	14:47942	*See* PB–89-187876/XAB			
EGG-EAST–					
8382	14:47135	NTIS, PC E04/MF E05 - OSTI; GPO Dep.	E 1.99:	DE89016192/JAW	MF-520
EGG-M–					
88520	14:47285	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016200/JAW	MF-362
89040	14:48742	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016214/JAW	MF-502
89091	14:47136	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016207/JAW	
89176	14:47003	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016355/JAW	MF-510
89245	14:46965	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016213/JAW	
EMR/ER–					
86-33(TR)	14:47239	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1. $3.40 CAN minimum, plus $0.25/p after 10 pages; MF $10 CAN.			
ENEA-RT-COMB–					
87-15	14:46927	NTIS (US Sales Only), PC A03/MF A01		DE88755371/JAW	
ENEA-RT-TIB–					
88-3	14:47111	NTIS (US Sales Only), PC A03/MF A01		DE88755372/JAW	
EOSR–					
1608-VOL-1	14:47712	*See* AD-A–207235/3/XAB			
EPA–					
330/9-89/003-R	14:47232	*See* PB–89-194526/XAB			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
430/09-89/001	14:48058	*See* PB–89-189633/XAB			
440/5-88/004	14:48074	*See* PB–89-195242/XAB			
450/3-88/001	14:46841	*See* PB–89-194237/XAB			
520/1-89/010	14:47963	*See* PB–89-189419/XAB			
520/5-89/011	14:47966	*See* PB–89-203756/XAB			
530/SW-88/031G	14:47290	*See* PB–89-142418/XAB			
530/SW-88/031J	14:47291	*See* PB–89-142442/XAB			
530/SW-88/031K	14:47292	*See* PB–89-142459/XAB			
600/3-89/030	14:47936	*See* PB–89-181218/XAB			
600/3-89/032	14:47947	*See* PB–89-189849/XAB			
600/9-89/028	14:48063	*See* PB–89-190409/XAB			
600/D-89/077	14:48146	*See* PB–89-181416/XAB			
600/J-88/218	14:47937	*See* PB–89-181317/XAB			
EPA/IMSD–					
88/002B	14:47230	*See* PB–89-189641/XAB			
EPA/OWPE–					
88/001	14:47293	*See* PB–89-208169/XAB			
EPA/ROD/R–					
01-88/028	14:48005	*See* PB–89-196778/XAB			
01-88/030	14:48057	*See* PB–89-188932/XAB			
01-88/032	14:48007	*See* PB–89-204747/XAB			
01-88/033	14:48080	*See* PB–89-204754/XAB			
02-88/065	14:47999	*See* PB–89-189492/XAB			
02-88/073	14:48004	*See* PB–89-196760/XAB			
03-88/052	14:48003	*See* PB–89-196752/XAB			
03-88/056	14:48002	*See* PB–89-196745/XAB			
03-88/058	14:48079	*See* PB–89-196737/XAB			
03-88/063	14:47970	*See* PB–89-204762/XAB			
04-88/038	14:48078	*See* PB–89-196729/XAB			
04-88/041	14:48077	*See* PB–89-196711/XAB			
05-88/081	14:48076	*See* PB–89-196703/XAB			
05-88/082	14:48006	*See* PB–89-196786/XAB			
05-88/084	14:48075	*See* PB–89-196695/XAB			
06-88/030	14:48008	*See* PB–89-204788/XAB			
06-88/040	14:48009	*See* PB–89-204796/XAB			
06-88/046	14:48055	*See* PB–89-182448/XAB			
07-88/012	14:48010	*See* PB–89-204838/XAB			
09-88/013	14:48001	*See* PB–89-196687/XAB			
09-88/018	14:48054	*See* PB–89-182406/XAB			
09-88/026	14:48011	*See* PB–89-204846/XAB			
EPRI-EL–					
6429	14:47081	Research Reports Center, Box 50490, Palo Alto, CA 94303			
EPRI-GS–					
6475-Vol.1	14:47764	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6475-Vol.2	14:47765	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6485	14:46823	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6517	14:46880	Research Reports Center, Box 50490, Palo Alto, CA 94303			
EPRI-NP–					
6180	14:47137	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6476	14:47138	Research Reports Center, Box 50490, Palo Alto, CA 94303			
6494	14:46966	Research Reports Center, Box 50490, Palo Alto, CA 94303			
ETDE-mf–					
0702692	14:47069	NTIS (US Sales Only), PC A11/MF A01		DE90702692/JAW	
0702693	14:46886	NTIS (US Sales Only), PC A06/MF A01		DE90702693/JAW	
0702694	14:47255	NTIS (US Sales Only), PC A15/MF A01		DE90702694/JAW	
0702695	14:47070	NTIS (US Sales Only), PC A10/MF A01		DE90702695/JAW	
0702697	14:46843	NTIS (US Sales Only), PC A06/MF A01		DE90702697/JAW	
0702726	14:47071	NTIS (US Sales Only), PC A04/MF A01		DE90702726/JAW	
0702751	14:46834	NTIS (US Sales Only), PC A07/MF A01		DE90702751/JAW	
0702776	14:47253	NTIS (US Sales Only), PC A04/MF A01		DE90702776/JAW	
0702816	14:47286	NTIS (US Sales Only), PC A03/MF A01		DE90702816/JAW	
0702817	14:47072	NTIS (US Sales Only), PC A03/MF A01		DE90702817/JAW	
0702833	14:47306	NTIS (US Sales Only), PC A05/MF A01		DE90702833/JAW	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
ETDE/CA-MS–					
BT31-2-1988-III-13	14:47211	Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; $20.00; OTHER COUNTRIES: $24.00 CAN; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1; $10 CAN.			
M-22-105-1988	14:47212	Energy, Mines and Resources Canada, Communications Branch, 580 Booth St., Ottawa, ON, CAN K1A 0E4; $N/C; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1; $10 CAN.			
ETEC-TDR–					
89-5	14:47100	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016805/JAW	MF-542
ETN–					
89-93745	14:48224	*See* SER-C-PREPUBL-FASC–29			
89-93746	14:48225	*See* SER-C-PREPUBL-FASC–30			
89-93748	14:48226	*See* SER-C-PREPUBL-FASC–32			
ETSU-B–					
1156	14:47031	British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ			
ETSU-G–					
137-P14A	14:47053	British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ			
137-P14B	14:47054	British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ			
137-P14C	14:47055	British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ			
145	14:47052	British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ			
ETSU-S–					
1214	14:47266	British Library Document Supply Centre, Boston Spa, Wetherby, West Yorks. LS23 7BQ			
EUR–					
11796-EN	14:46835	British Coal Corporation, Stoke Orchard (United Kingdom). Coal Research Establishment; Commission of the European Communities, Luxembourg			
FAGO/ESRU–					
89.08.K	14:47267	Technische Universiteit Eindhoven, Vakgroep FAGO, P.O. Box 513, 5600 MB Eindhoven, Netherlands			
FERMILAB-PUB–					
89/31-A	14:48417	*See* N–89-21634			
89/32-A	14:48190	*See* N–89-20896			
89/42-A	14:48218	*See* N–89-21716			
89/44-A	14:48216	*See* N–89-21635			
89/47-A	14:48416	*See* N–89-21633			
89/49-A	14:48189	*See* N–89-20880			
FIAS-R–					
175	14:48246	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600777/JAW	
177	14:48247	NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS		DE90600798/JAW	
178	14:48248	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600778/JAW	
179	14:48249	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600779/JAW	
185	14:48250	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600799/JAW	
188	14:48251	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600800/JAW	
189	14:48252	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600780/JAW	
192	14:48253	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600801/JAW	
194	14:48254	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600781/JAW	
195	14:48255	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600802/JAW	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
197	14:48256	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600803/JAW	
198	14:48257	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600804/JAW	
FNAL-TM–					
1574	14:47784	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016706/JAW	PC-414
1588	14:47807	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016705/JAW	PC-406
1593	14:47785	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016707/JAW	PC-406
1603	14:47793	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016711/JAW	PC-414
1607	14:47794	NTIS, PC A02/MF A01; OSTI; INIS		DE89016709/JAW	PC-414
1613	14:47352	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016710/JAW	PC-404
FNAL/C–					
89/170-E	14:47825	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016733/JAW	MF-414
89/182	14:47783	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017651/JAW	MF-414
FRNC-TH–					
3498	14:47287	NTIS (US Sales Only), PC A13/MF A01		DE90702240/JAW	
FTUV–					
89-26	14:48357	*See* SLAC-PUB–5057			
GA-A–					
19823	14:47114	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017241/JAW	MF-522
GEOMET-IE–					
1945	14:47952	*See* PB–89-194104/XAB			
GRI–					
89/0095	14:46910	*See* PB–89-205090/XAB			
89/0119	14:46904	*See* PB–89-195812/XAB			
89/0131	14:46909	*See* PB–89-204085/XAB			
GRL–					
8803	14:48462	*See* AD-A–205371/8/XAB			
GRS-F–					
172	14:47139	NTIS (US Sales Only), PC A19/MF A01		DE90703171/JAW	
173	14:47140	NTIS (US Sales Only), PC A20/MF A01		DE90702849/JAW	
GSC-TR–					
89-007	14:48051	*See* PB–89-149314/XAB			
GSI–					
89-1	14:48431	NTIS (US Sales Only), PC A21/MF A01		DE90702847/JAW	
GTRI-A–					
4699-2	14:47408	*See* AD-A–206061/4/XAB			
HETA–					
87-300-0000	14:47944	*See* PB–89-188007/XAB			
HMI-B–					
466	14:48432	NTIS (US Sales Only), PC A12/MF A01		DE90703167/JAW	
IAEA-TECDOC–					
505	14:47083	NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS		DE90601635/JAW	
IASSNS-HEP–					
89/29	14:48385	*See* CONF-8902132–1			
IBP-GB–					
14/86	14:47268	NTIS (US Sales Only), PC A03/MF A01		DE90702823/JAW	
IBP-SA–					
3/85	14:47269	NTIS (US Sales Only), PC A03/MF A01		DE90702824/JAW	
IC–					
88/370	14:48499	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600816/JAW	
88/418	14:48386	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600758/JAW	
89/105	14:48553	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600730/JAW	
89/107	14:48554	NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS		DE90600731/JAW	
89/109	14:48327	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601087/JAW	
89/112	14:48390	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600759/JAW	
89/113	14:48501	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600817/JAW	
89/114	14:48391	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600760/JAW	
89/116	14:48555	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600716/JAW	
89/117	14:48556	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600717/JAW	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
89/118	14:48557	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600732/JAW	
89/119	14:48558	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600718/JAW	
89/120	14:48559	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600733/JAW	
89/123	14:48468	NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS		DE90601096/JAW	
89/124	14:48469	NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS		DE90601097/JAW	
89/125	14:48560	NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS		DE90600734/JAW	
89/127	14:48392	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600761/JAW	
89/128	14:48393	NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS		DE90600762/JAW	
89/129	14:48394	NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS		DE90600763/JAW	
89/134	14:48561	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600719/JAW	
89/135	14:48586	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601020/JAW	
89/136	14:48470	NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS		DE90601098/JAW	
89/138	14:48587	NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS		DE90601021/JAW	
89/142	14:48562	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600720/JAW	
89/143	14:47918	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601303/JAW	
89/146	14:48588	NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS		DE90600984/JAW	
89/153	14:48563	NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS		DE90600754/JAW	
89/154	14:48395	NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS		DE90600764/JAW	
89/155	14:48259	NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS		DE90600782/JAW	
89/41	14:48387	NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS		DE90600765/JAW	
89/56	14:48540	NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS		DE90600755/JAW	
89/57	14:48541	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600722/JAW	
89/58	14:48542	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600723/JAW	
89/61	14:48543	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600735/JAW	
89/66	14:48544	NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS		DE90600724/JAW	
89/69	14:48500	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600818/JAW	
89/70	14:48545	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600725/JAW	
89/78	14:48546	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600726/JAW	
89/79	14:47389	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601252/JAW	
89/85	14:48547	NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS		DE90600736/JAW	
89/86	14:48548	NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS		DE90600727/JAW	
89/87	14:48549	NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS		DE90600728/JAW	
89/88	14:48550	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600737/JAW	
89/89	14:48530	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601082/JAW	
89/90	14:48388	NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS		DE90600766/JAW	
89/92	14:48467	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601099/JAW	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
89/93	14:48551	NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS		DE90600729/JAW	
89/94	14:48286	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600934/JAW	
89/95	14:48326	NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS		DE90601088/JAW	
89/97	14:48258	NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS		DE90600805/JAW	
89/98	14:48389	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600767/JAW	
89/99	14:48552	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600756/JAW	
ICASE–					
89-3	14:48574	*See* N–89-20636			
89-5	14:48573	*See* N–89-20635			
ICOMP–					
89-2	14:48575	*See* N–89-20710			
IEPA/ENV–					
89-012	14:47226	*See* PB–89-174239/XAB			
IGCE–					
7609	14:47026	CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1; $0.34CAN per page, $3.40 CAN minimum			
IIT-E–					
06595-3	14:48159	*See* AD-A–208198/2/XAB			
IMAG-Note–					
400	14:47288	Institute of Agicultural Engineering (IMAG), P.O. Box 43, 6700 AA Wageningen, Netherlands			
INDC(JPN)–					
124/L	14:48433	*See* JAERI-M–89-083			
125/L	14:48447	*See* JAERI-M–89-089			
INIS-BR–					
1586	14:48448	NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS		DE90601116/JAW	
1589	14:47547	NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS		DE90601153/JAW	
INIS-GB–					
199	14:47013	NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS		DE90601678/JAW	
INIS-SU–					
112	14:47359	NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS		DE89018004/JAW	
113/A	14:48173	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE89018003/JAW	
INIS-XN–					
185	14:47143	NTIS (US Sales Only), PC A04/MF A01 - OSTI; INIS		DE90601395/JAW	
INIS-mf–					
11515	14:48172	NTIS (US Sales Only), PC A07/MF A01 - OSTI; INIS		DE90600715/JAW	
11529	14:48128	NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS		DE90601325/JAW	
11532	14:48709	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601776/JAW	
11533	14:48710	NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS		DE90601777/JAW	
11534	14:46926	NTIS (US Sales Only), PC A02/MF A01 - OSTI; INIS		DE90601286/JAW	
11535	14:47141	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601790/JAW	
11536	14:47010	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601750/JAW	
11537	14:48581	NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS		DE90600936/JAW	
11997	14:47014	NTIS (US Sales Only), PC A03/MF A01		DE90702759/JAW	
11999	14:47548	NTIS (US Sales Only), PC A03/MF A01		DE90702746/JAW	
12001	14:47142	NTIS (US Sales Only), PC A03/MF A01		DE90702753/JAW	
INS-T–					
487	14:48490	NTIS (US Sales Only), PC A03/MF A01		DE90701779/JAW	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
IPNO-DRE–					
88-28	14:48348	NTIS (US Sales Only), PC A03/MF A01		DE90701549/JAW	
IPP–					
2/297	14:48644	NTIS (US Sales Only), PC A04/MF A01		DE90702887/JAW	
6/277	14:48515	NTIS (US Sales Only), PC A03/MF A01		DE90702888/JAW	
IPPCZ–					
281	14:48645	NTIS (US Sales Only), PC A03/MF A01; OSTI; INIS		DE89018005/JAW	
IPPJ–					
895	14:48516	NTIS (US Sales Only), PC A03/MF A01		DE90701582/JAW	
896	14:48648	NTIS (US Sales Only), PC A03/MF A01		DE90701583/JAW	
897	14:48649	NTIS (US Sales Only), PC A03/MF A01		DE90701584/JAW	
898	14:48650	NTIS (US Sales Only), PC A03/MF A01		DE90701585/JAW	
901	14:48517	NTIS (US Sales Only), PC A03/MF A01		DE90701758/JAW	
902	14:48684	NTIS (US Sales Only), PC A03/MF A01		DE90701757/JAW	
904	14:48651	NTIS (US Sales Only), PC A03/MF A01		DE90701755/JAW	
IPPJ-DT–					
145	14:48685	NTIS (US Sales Only), PC A03/MF A01		DE90701616/JAW	
150	14:48726	NTIS (US Sales Only), PC A03/MF A01		DE90701798/JAW	
151	14:48743	NTIS (US Sales Only), PC A04/MF A01		DE90701799/JAW	
IVO-A–					
05/89	14:47082	NTIS (US Sales Only), PC A04/MF A01		DE89914698/JAW	
IVO-B–					
03/89	14:47079	NTIS (US Sales Only), PC A04/MF A01		DE89914700/JAW	
04/89	14:47075	NTIS (US Sales Only), PC A04/MF A01		DE89914699/JAW	
IWGFPT–					
31	14:47085	NTIS (US Sales Only), PC A05/MF A01 - OSTI; INIS		DE90601639/JAW	
JA–					
6148	14:47737	*See* AD-A–204228/1/XAB			
JACKFAU–					
89-351	14:47209	*See* PB–89-187918/XAB			
JAERI–					
1315	14:47553	NTIS (US Sales Only), PC A06/MF A01		DE90701676/JAW	
JAERI-M–					
88-260	14:47015	NTIS (US Sales Only), PC A07/MF A01		DE90701620/JAW	
89-011	14:47993	NTIS (US Sales Only), PC A03/MF A01		DE90701622/JAW	
89-014	14:46931	NTIS (US Sales Only), PC A09/MF A01		DE90701623/JAW	
89-017	14:47961	NTIS (US Sales Only), PC A05/MF A01		DE90701645/JAW	
89-019	14:47102	NTIS (US Sales Only), PC A03/MF A01		DE90701783/JAW	
89-021	14:48652	NTIS (US Sales Only), PC A03/MF A01		DE90701784/JAW	
89-027	14:47095	NTIS (US Sales Only), PC A06/MF A01		DE90701707/JAW	
89-028	14:48686	NTIS (US Sales Only), PC A04/MF A01		DE90701678/JAW	
89-029	14:47751	NTIS (US Sales Only), PC A03/MF A01		DE90701646/JAW	
89-030	14:47104	NTIS (US Sales Only), PC A06/MF A01		DE90701752/JAW	
89-032	14:46932	NTIS (US Sales Only), PC A07/MF A01		DE90701679/JAW	
89-036	14:48653	NTIS (US Sales Only), PC A03/MF A01		DE90701782/JAW	
89-039	14:47109	NTIS (US Sales Only), PC A03/MF A01		DE90701699/JAW	
89-040	14:48687	NTIS (US Sales Only), PC A03/MF A01		DE90701785/JAW	
89-042	14:47829	NTIS (US Sales Only), PC A03/MF A01		DE90701708/JAW	
89-043	14:47118	NTIS (US Sales Only), PC A03/MF A01		DE90701700/JAW	
89-044	14:47106	NTIS (US Sales Only), PC A15/MF A01		DE90701709/JAW	
89-050	14:48654	NTIS (US Sales Only), PC A03/MF A01		DE90701750/JAW	
89-054	14:48744	NTIS (US Sales Only), PC A07/MF A01		DE90701751/JAW	
89-057	14:46967	NTIS (US Sales Only), PC A03/MF A01		DE90701781/JAW	
89-083	14:48433	Japan Atomic Energy Research Institute, Tokai-mura, Naka-gun, Ibaraki-ken 319-11, Japan			
89-089	14:48447	Japan Atomic Energy Research Institute, Tokai-mura, Naka-gun, Ibaraki-ken 319-11, Japan			
JINR-E–					
2-88-363	14:48316	NTIS (US Sales Only), PC A06/MF A01 - OSTI; INIS		DE89018001/JAW	
JPL-PUBL–					
88-17	14:47437	*See* N–89-20821			
88-39	14:47032	*See* N–89-20549			
Juel–					
2262	14:46920	NTIS (US Sales Only), PC A10/MF A01		DE90702841/JAW	
2264	14:46889	NTIS (US Sales Only), PC A10/MF A01		DE90702844/JAW	
2277	14:47096	NTIS (US Sales Only), PC A07/MF A01		DE90702785/JAW	
Juel-Spez–					
494	14:48356	NTIS (US Sales Only), PC A09/MF A01		DE90702846/JAW	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
K/ITP–					
290	14:47322	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016878/JAW	MF-515
K/QT–					
230-R	14:46968	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016576/JAW	MF-517
KEK–					
88-12	14:48408	NTIS (US Sales Only), PC A15/MF A01		DE90001080/JAW	
88-13	14:47811	NTIS (US Sales Only), PC A03/MF A01		DE90701703/JAW	
88-15	14:47812	NTIS (US Sales Only), PC A10/MF A01		DE90701710/JAW	
88-16	14:47817	NTIS (US Sales Only), PC A06/MF A01		DE90701702/JAW	
KEK-PR–					
88-3	14:48711	NTIS (US Sales Only), PC A18/MF A01		DE90701894/JAW	
KFK–					
4477	14:47144	NTIS (US Sales Only), PC A08/MF A01		DE90702845/JAW	
4574	14:47145	NTIS (US Sales Only), PC A08/MF A01		DE90702850/JAW	
4592	14:48129	NTIS (US Sales Only), PC A07/MF A01		DE90702851/JAW	
KFK-PEF–					
49	14:48142	NTIS (US Sales Only), PC A05/MF A01		DE90702738/JAW	
KFK-PWAB–					
1	14:48021	NTIS (US Sales Only), PC A12/MF A01		DE90702886/JAW	
KFKI–					
1989-36/C	14:48182	NTIS (US Sales Only), PC A03/MF A01 - OSTI		DE89016049/JAW	
KURRI-TR–					
310	14:47240	NTIS (US Sales Only), PC A04/MF A01		DE89018006/JAW	
314	14:48493	NTIS (US Sales Only), PC A03/MF A01		DE90701780/JAW	
L–					
16549	14:47434	*See* N–89-19385			
LA–					
11228-MS	14:47795	NTIS, PC A03/MF A01			
11514-MS	14:47056	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016687/JAW	MF-251
11570-MS	14:47855	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015178/JAW	MF-741
11572-MS	14:48752	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017786/JAW	PC-700
11586-MS	14:46930	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017746/JAW	PC-704; PC-711
11646-MS	14:46928	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE90000004/JAW	PC-700
11686-C	14:48582	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016956/JAW	PC-910
LA-SUB–					
89-6	14:47845	NTIS, PC A03/MF A01 - OSTI		DE89017321/JAW	MF-406
LA-UR–					
89-1347	14:47008	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016608/JAW	MF-940
89-1584	14:47752	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89012623/JAW	MF-706
89-2324	14:48518	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89015269/JAW	MF-411; MF-404
89-2482	14:48183	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89015299/JAW	MF-414
89-2500	14:48271	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015296/JAW	
89-2506	14:48272	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015294/JAW	MF-700
89-2529	14:48240	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015291/JAW	MF-702
89-2620	14:48273	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016994/JAW	MF-700
89-2630	14:46969	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016993/JAW	MF-810
89-2657	14:47846	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016990/JAW	MF-706
89-2660	14:48727	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016989/JAW	MF-905
89-2661	14:47753	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016776/JAW	MF-905
89-2664	14:48161	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016590/JAW	MF-703
89-2671	14:47719	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016775/JAW	MF-706
89-2680	14:48531	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016774/JAW	MF-904; MF-906
89-2685	14:47430	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016589/JAW	MF-401
89-2686	14:48184	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016591/JAW	MF-700
89-2687	14:48655	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016771/JAW	MF-712
89-2710	14:48656	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016768/JAW	MF-712
89-2713	14:47247	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016999/JAW	MF-900
89-2717	14:48287	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016997/JAW	MF-706
89-2718	14:48519	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016594/JAW	MF-700
89-2740	14:48241	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016596/JAW	MF-412
89-2744	14:48473	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016598/JAW	MF-700
89-2746	14:48242	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016585/JAW	MF-412
89-2773	14:47856	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016037/JAW	MF-741
89-2779	14:48318	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016036/JAW	MF-412
89-2783	14:47857	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016979/JAW	
89-2788	14:48474	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016978/JAW	MF-413
89-2806	14:47431	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016972/JAW	MF-901
89-2828	14:48728	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016986/JAW	MF-705

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
89-2840	14:47432	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016985/JAW	
89-2858	14:47925	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016984/JAW	MF-402
89-2864	14:47433	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016983/JAW	MF-741
89-2867	14:47743	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016982/JAW	MF-706
89-2869	14:47370	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016981/JAW	MF-704
89-2877	14:47201	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016617/JAW	MF-706
89-2885	14:48532	NTIS, PC A03; OSTI; INIS; GPO Dep.	E 1.99:	DE89016616/JAW	MF-904
89-2894	14:47786	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016614/JAW	
89-2898	14:47858	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016612/JAW	MF-741
89-2915	14:47744	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016609/JAW	
89-2921	14:47766	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016970/JAW	MF-741
89-2936	14:47859	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016967/JAW	MF-741
89-2952	14:46970	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016778/JAW	MF-802
89-2961	14:48185	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016755/JAW	MF-700
89-2962	14:48186	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016784/JAW	MF-910
89-2964	14:47919	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016783/JAW	MF-402; MF-405
89-2981	14:48475	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016971/JAW	MF-413
LNCC–					
028/88	14:48572	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90600742/JAW	
MHWMC–					
8808	14:47225	Manitoba Hazardous Waste Management Corporation, 226-530 Century Street, Winnipeg, MB, CAN R3H 0Y4; PRICES UPON REQUEST, FUNDS CAN; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1; $10 CAN.			
MICROLOG–					
87-02838	14:47211	*See* ETDE/CA-MS–BT31-2-1988-III-13			
87-03257	14:47239	*See* EMR/ER–86-33(TR)			
88-05907	14:47254	*See* SOQUIP–1988			
89-02618	14:48160	*See* OH/RD–88-104-K			
89-02713	14:47251	*See* UR/CPRC–1989			
89-02979	14:47225	*See* MHWMC–8808			
89-03033	14:47212	*See* ETDE/CA-MS–M-22-105-1988			
89-03616	14:46914	*See* NPA–BT31-1990-III-31			
89-03890	14:47235	*See* SEMR–8803			
MIT/LCS/TR–					
434	14:48718	*See* AD-A–207833/5/XAB			
MLM–					
3598	14:48729	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016959/JAW	PC-701
MLM-MU–					
89-68-0001	14:48730	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015176/JAW	MF-705
MS–					
8017	14:47763	*See* AD-A–207589/3/XAB			
MT-CWR–					
089-033	14:47374	*See* ORNL/Sub–85-27421/03			
MTCI–					
79881-104-F	14:46790	*See* DOE/PC/79881–T1			
MTI–					
87TR56	14:47776	*See* N–89-20472			
87TR72	14:47720	*See* N–89-21239			
MTL-TR–					
89-31	14:47328	*See* AD-A–207647/9/XAB			
N–					
00014-81-K-0653	14:48445	*See* AD-A–207446/6/XAB			
89-19222	14:48187	NTIS, PC A04/MF A01			
89-19385	14:47434	NTIS, PC A03/MF A01			
89-19421	14:47395	NTIS, PC A06/MF A01			
89-19493	14:47043	NTIS, PC A03/MF A01			
89-19539	14:47745	NTIS, PC A02/MF A01			
89-20135	14:47774	NTIS, PC A06/MF A01			
89-20205	14:47435	NTIS, PC A02/MF A01			
89-20206	14:47436	NTIS, PC A03/MF A01			
89-20252	14:47396	NTIS, PC A03/MF A01			
89-20447	14:47746	NTIS, PC A03/MF A01			
89-20472	14:47776	NTIS, PC A06/MF A01			
89-20545	14:47263	NTIS, PC A03/MF A01			
89-20549	14:47032	NTIS, PC A03/MF A01			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
89-20635	14:48573	NTIS, PC A03/MF A01			
89-20636	14:48574	NTIS, PC A03/MF A01			
89-20641	14:48731	NTIS, PC A02/MF A01			
89-20684	14:48732	NTIS, PC A02/MF A01			
89-20685	14:48733	NTIS, PC A02/MF A01			
89-20710	14:48575	NTIS, PC A03/MF A01			
89-20821	14:47437	NTIS, PC A04/MF A01			
89-20875	14:48188	NTIS, PC A03/MF A01			
89-20880	14:48189	NTIS, PC A02/MF A01			
89-20896	14:48190	NTIS, PC A03/MF A01			
89-21025	14:47754	NTIS, PC A03/MF A01			
89-21046	14:47397	NTIS, PC A07/MF A01			
89-21047	14:47438	NTIS, PC A03/MF A01			
89-21051	14:46903	NTIS, PC A02/MF A01			
89-21100	14:47033	NTIS, PC A03/MF A01			
89-21103	14:47543	NTIS, PC A03/MF A01			
89-21104	14:47439	NTIS, PC A03/MF A01			
89-21174	14:47044	NTIS, PC A03/MF A01			
89-21226	14:47747	NTIS, PC A03/MF A01			
89-21239	14:47720	NTIS, PC A08/MF A01			
89-21256	14:47440	NTIS, PC A04/MF A01			
89-21286	14:47441	NTIS, PC A12/MF A01			
89-21419	14:47203	NTIS, PC A03/MF A01			
89-21633	14:48416	NTIS, PC A02/MF A01			
89-21634	14:48417	NTIS, PC A03/MF A01			
89-21635	14:48216	NTIS, PC A03/MF A01			
89-21658	14:48657	NTIS, PC A04/MF A01			
89-21712	14:48217	NTIS, PC A04/MF A01			
89-21716	14:48218	NTIS, PC A05/MF A01			
NAC–					
85-06	14:47813	the National Accelerator Centre, Council for Scientific and Industrial Research, PO Box 72, Faure, 7131, South Africa			
87-01	14:48111	the National Accelerator Centre, Council for Scientific and Industrial Research, PO Box 72, Faure, 7131, South Africa			
87-03	14:47832	the National Accelerator Centre, Council for Scientific and Industrial Research, PO Box 72, Faure, 7131, South Africa			
NAS–					
1.15:100360	14:48217	*See* N–89-21712			
1.15:100496	14:47438	*See* N–89-21047			
1.15:101466	14:48575	*See* N–89-20710			
1.15:101482	14:47436	*See* N–89-20206			
1.15:101487	14:47263	*See* N–89-20545			
1.15:101952	14:48732	*See* N–89-20684			
1.15:101953	14:48733	*See* N–89-20685			
1.15:101955	14:47033	*See* N–89-21100			
1.15:101964	14:47396	*See* N–89-20252			
1.15:101971	14:47439	*See* N–89-21104			
1.15:101973	14:47754	*See* N–89-21025			
1.15:101975	14:46903	*See* N–89-21051			
1.15:101980	14:47203	*See* N–89-21419			
1.15:101981	14:47043	*See* N–89-19493			
1.15:102008	14:47044	*See* N–89-21174			
1.15:4087	14:47774	*See* N–89-20135			
1.15:4103	14:48731	*See* N–89-20641			
1.15:89284	14:48188	*See* N–89-20875			
1.26:177525	14:47397	*See* N–89-21046			
1.26:179525	14:47395	*See* N–89-19421			
1.26:180480	14:47747	*See* N–89-21226			
1.26:180899	14:47776	*See* N–89-20472			
1.26:181771	14:48574	*See* N–89-20636			
1.26:181773	14:48573	*See* N–89-20635			
1.26:182105	14:47720	*See* N–89-21239			
1.26:182283	14:48657	*See* N–89-21658			
1.26:182818	14:47435	*See* N–89-20205			
1.26:182820	14:47745	*See* N–89-19539			
1.26:182836	14:48218	*See* N–89-21716			
1.26:182918	14:48216	*See* N–89-21635			
1.26:182958	14:48189	*See* N–89-20880			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
1.26:184803	14:48187	*See* N–89-19222			
1.26:184813	14:47746	*See* N–89-20447			
1.26:184863	14:47032	*See* N–89-20549			
1.26:184864	14:47437	*See* N–89-20821			
1.26:184889	14:48417	*See* N–89-21634			
1.26:184890	14:48416	*See* N–89-21633			
1.26:184892	14:48190	*See* N–89-20896			
1.26:184966	14:47441	*See* N–89-21286			
1.26:4195	14:47440	*See* N–89-21256			
1.60:2906	14:47434	*See* N–89-19385			
1.60:2910	14:47543	*See* N–89-21103			
9016558	14:47241	NTIS, PC A03/MF A01 - OSTI		DE89016558/JAW	
NASA-CR–					
177525	14:47397	*See* N–89-21046			
179525	14:47395	*See* N–89-19421			
180480	14:47747	*See* N–89-21226			
180899	14:47776	*See* N–89-20472			
181771	14:48574	*See* N–89-20636			
181773	14:48573	*See* N–89-20635			
182105	14:47720	*See* N–89-21239			
182283	14:48657	*See* N–89-21658			
182818	14:47435	*See* N–89-20205			
182820	14:47745	*See* N–89-19539			
182836	14:48218	*See* N–89-21716			
182918	14:48216	*See* N–89-21635			
182958	14:48189	*See* N–89-20880			
184803	14:48187	*See* N–89-19222			
184813	14:47746	*See* N–89-20447			
184863	14:47032	*See* N–89-20549			
184864	14:47437	*See* N–89-20821			
184889	14:48417	*See* N–89-21634			
184890	14:48416	*See* N–89-21633			
184892	14:48190	*See* N–89-20896			
184966	14:47441	*See* N–89-21286			
4195	14:47440	*See* N–89-21256			
NASA-TM–					
100360	14:48217	*See* N–89-21712			
100496	14:47438	*See* N–89-21047			
101466	14:48575	*See* N–89-20710			
101482	14:47436	*See* N–89-20206			
101487	14:47263	*See* N–89-20545			
101952	14:48732	*See* N–89-20684			
101953	14:48733	*See* N–89-20685			
101955	14:47033	*See* N–89-21100			
101964	14:47396	*See* N–89-20252			
101971	14:47439	*See* N–89-21104			
101973	14:47754	*See* N–89-21025			
101975	14:46903	*See* N–89-21051			
101980	14:47203	*See* N–89-21419			
101981	14:47043	*See* N–89-19493			
102008	14:47044	*See* N–89-21174			
102122	14:47421	*See* DOE/NASA/16310–10			
102307	14:47351	*See* DOE/NASA/16310–11			
4087	14:47774	*See* N–89-20135			
4103	14:48731	*See* N–89-20641			
89284	14:48188	*See* N–89-20875			
NASA-TP–					
2906	14:47434	*See* N–89-19385			
2910	14:47543	*See* N–89-21103			
NCAR/CT–					
25	14:48220	*See* PB–89-185300/XAB			
NCRP–					
101	14:48130	National Council on Radiation Protection and Measurement Publications, 7910 Woodmont Ave., Suite 800, Bethesda, MD 20814 $15.00			
NEANDC(J)–					
137/U	14:48433	*See* JAERI-M–89-083			
138/U	14:48447	*See* JAERI-M–89-089			
NEI-NO–					
83	14:48012	NTIS (US Sales Only), PC A16/MF A01		DE89787775/JAW	

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
NIPER–					
200	14:46836	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89000761/JAW	PC-125
272	14:46891	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89000764/JAW	PC-122
308	14:46892	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89000762/JAW	PC-122
400	14:46893	NTIS, PC A21/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89000759/JAW	PC-122; PC-125
NISTIR–					
89/4069	14:47273	*See* PB–89-189153/XAB			
NORDA-FR–					
89-009-351	14:48717	*See* AD-A–207809/5/XAB			
NOVEM–					
89-007	14:47288	*See* IMAG-Nota–400			
89-052	14:47274	*See* PEUTZ-E–160-2			
89-056	14:47267	*See* FAGO/ESRU–89.08.K			
NPA–					
BT31-1990-III-31	14:46914	Northern Pipeline Agency, Lester B. Pearson Building, 125 Sussex Drive, Ottawa, ON, CAN K1A 0G2; $3.00; OTHER COUNTRIES: $3.60 CAN; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1; $10 CAN.			
NRL-MR–					
6402	14:48175	*See* AD-A–207311/2/XAB			
6405	14:48583	*See* AD-A–207310/4/XAB			
NUKEM-FuE–					
88034	14:47097	NTIS (US Sales Only), PC A03/MF A01		DE90702801/JAW	
NUREG–					
1365	14:47146	NTIS, PC A03/MF A01 - GPO; OSTI; INIS		TI89016875/JAW	
NUREG/CR–					
4234-Vol.2	14:47147	NTIS, PC A10/MF A01 - GPO; OSTI; INIS		TI89015547/JAW	
5338	14:47105	NTIS, PC A04/MF A01 - GPO; OSTI; INIS		TI89016556/JAW	
5396	14:47148	NTIS, PC A04/MF A01 - GPO - OSTI		TI89015412/JAW	
OCS/EIS/EA/MMS–					
89-0053	14:48082	OSTI; US Department of Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA 70123-2394		TI89016551/JAW	
89-0061	14:48083	OSTI - US Dept. of Interior, Minerals Management Serv., 381 Elden St., Herndon, VA 22070		TI89017620/JAW	
OH/RD–					
88-104-K	14:48160	Ontario Hydro Research Division, Records Clerk, Bldg. KR 107, 800 Kipling Ave., Etobicoke, ON, CAN M8Z 5S4; $N/C; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1; $10 CAN.			
ORNL–					
6170/V2	14:47147	*See* NUREG/CR–4234-Vol.2			
6451	14:48143	NTIS, PC A13/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016892/JAW	
6540/V1	14:47242	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015685/JAW	MF-400
6555	14:47460	NTIS, PC A10/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015647/JAW	PC-401
ORNL/CON–					
274	14:47270	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015687/JAW	MF-350
ORNL/CSD/FTR–					
3112	14:47833	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017361/JAW	MF-405
ORNL/FTR–					
2464	14:47796	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017414/JAW	MF-414
2634	14:47371	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017398/JAW	MF-404
2726	14:47834	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017406/JAW	MF-414
2801	14:46921	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017424/JAW	MF-400
2816	14:47372	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017416/JAW	MF-404
2818	14:47927	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017404/JAW	MF-402
2822	14:48022	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017405/JAW	MF-402
2823	14:47974	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017377/JAW	MF-408
2825	14:48275	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017422/JAW	MF-411
2828	14:47098	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017287/JAW	MF-522
2829	14:47847	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017303/JAW	MF-404; MF-410
2831	14:47761	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017286/JAW	MF-404
2833	14:47297	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017408/JAW	MF-402
2836	14:47149	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017428/JAW	MF-402

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
2842	14:46881	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017396/JAW	MF-103
2843	14:48688	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017288/JAW	MF-420
2844	14:47398	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017304/JAW	MF-404
2849	14:47373	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017434/JAW	MF-312
2859	14:47399	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017285/JAW	MF-404
2860	14:47797	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017415/JAW	MF-414
2866	14:47975	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017403/JAW	MF-408
2872	14:47818	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017385/JAW	MF-414
2877	14:48658	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017449/JAW	MF-421
2893	14:48434	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017487/JAW	MF-413
2894	14:48435	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017276/JAW	MF-413
2907	14:47107	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017295/JAW	
2919	14:48319	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017281/JAW	MF-414
2926	14:47115	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017296/JAW	
2928	14:47819	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017437/JAW	MF-413
2932	14:48476	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017436/JAW	MF-413
2936	14:48477	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017438/JAW	MF-413
2939	14:48131	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017435/JAW	MF-408
2940	14:48478	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017397/JAW	MF-413
2947	14:47814	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017492/JAW	MF-414
2955	14:47835	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017488/JAW	MF-414
2969	14:47289	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017463/JAW	MF-406
2973	14:48088	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017430/JAW	MF-408
2976	14:48089	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017429/JAW	MF-408
2977	14:48132	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017413/JAW	MF-408
2978	14:48097	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017412/JAW	MF-408
2980	14:48479	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017280/JAW	MF-413
2988	14:48480	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017489/JAW	MF-413
2992	14:48481	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017495/JAW	MF-410; MF-413
3023	14:48144	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017407/JAW	MF-721
3025	14:48482	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017491/JAW	MF-413
3063	14:48276	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017372/JAW	MF-411
3065	14:48133	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017433/JAW	MF-408
3082	14:47928	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017376/JAW	MF-402; MF-408
3092	14:48533	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017451/JAW	MF-411
3105	14:47087	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017386/JAW	MF-520; MF-523
3121	14:47929	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017418/JAW	MF-402
3122	14:47787	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017374/JAW	MF-413
3130	14:47150	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017393/JAW	MF-520
3131	14:48689	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017417/JAW	MF-423
3132	14:47994	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017364/JAW	MF-507
3136	14:47317	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017478/JAW	MF-334
3142	14:48452	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017373/JAW	MF-413
3144	14:48134	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017367/JAW	MF-407
3148	14:47930	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017366/JAW	MF-402
3151	14:46882	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017387/JAW	MF-400
3153	14:47976	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017368/JAW	MF-402
3166	14:48436	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017375/JAW	MF-414
3167	14:48483	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017427/JAW	MF-413
3171	14:48171	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017369/JAW	MF-403
3174	14:47788	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017378/JAW	MF-413
3177	14:46971	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017370/JAW	MF-402
3189	14:48145	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017431/JAW	MF-408
3190	14:48090	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017382/JAW	MF-408
3192	14:48117	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017354/JAW	MF-402
3195	14:47931	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017371/JAW	MF-403; MF-401
3211	14:47035	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017390/JAW	MF-402
3213	14:47932	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017391/JAW	MF-402
3222	14:48459	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017351/JAW	MF-414
3229	14:48277	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017381/JAW	MF-414
3230	14:46972	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017389/JAW	MF-402
3237	14:47836	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017350/JAW	MF-414
3238	14:48091	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017384/JAW	MF-408
3256	14:48135	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017450/JAW	MF-408
3259	14:48013	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017388/JAW	MF-403
3281	14:48520	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017479/JAW	MF-414
3286	14:47400	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017466/JAW	MF-404

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
3288	14:47534	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017474/JAW	MF-406
3297	14:47036	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017468/JAW	MF-270
3301	14:48049	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017467/JAW	MF-402
3305	14:48023	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017383/JAW	MF-403
3307	14:47271	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017469/JAW	MF-350
3308	14:48521	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017439/JAW	MF-414
3346	14:46973	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016791/JAW	MF-721
3349	14:48534	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016543/JAW	MF-404
3352	14:47037	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017334/JAW	MF-408
3355	14:48024	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017234/JAW	MF-403
ORNL/M–					
772	14:47243	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017454/JAW	MF-400
879	14:47272	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015666/JAW	MF-350
ORNL/RASA–					
88/38	14:47995	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016468/JAW	MF-511
88/40	14:47996	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016792/JAW	MF-511
88/80	14:47997	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017339/JAW	MF-511
88/84	14:47998	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017340/JAW	MF-511
ORNL/RSIC–					
52	14:47116	NTIS, PC A06/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89015664/JAW	MF-520
ORNL/Sub–					
85-27421/03	14:47374	NTIS, PC A09/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017452/JAW	MF-114
86-95901/01	14:46824	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017456/JAW	MF-113
87-00184/01	14:47401	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017455/JAW	MF-114
88-SC557/1	14:47103	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89015661/JAW	MF-940
89-SD212V/1	14:48025	NTIS, PC A05/MF A01 - OSTI		DE89015662/JAW	MF-402
ORNL/TM–					
10568	14:48491	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015658/JAW	
10968	14:46974	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89015650/JAW	MF-802
11033	14:47119	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89015655/JAW	PC-400
11050	14:46975	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015681/JAW	MF-721
11056	14:48026	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015678/JAW	MF-402
11106	14:47105	*See* NUREG/CR–5338			
11121	14:47933	NTIS, PC A11/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015677/JAW	
11141	14:46976	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015674/JAW	
11142	14:48746	NTIS, PC A21/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015673/JAW	
11146	14:47208	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015672/JAW	
11172	14:47004	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016918/JAW	MF-511
11215	14:48747	NTIS, PC A17/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016933/JAW	
11216	14:48027	NTIS, PC A11/MF A01; OSTI; INIS		DE89016934/JAW	MF-402
11265	14:48028	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016940/JAW	
11300	14:48029	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016916/JAW	
OY/PSTL-TIED–					
64	14:47038	NTIS (US Sales Only), PC A03/MF A01		DE89914696/JAW	
65	14:47039	NTIS (US Sales Only), PC A05/MF A01		DE89914697/JAW	
PATENTS-USA–					
4,832,704	14:46831	Patent and Trademark Office, Box 9, Washington, DC 20232			
6-801,895	14:47407	NTIS, PC A02/MF A01			
7-335,649	14:47733	NTIS, PC A03/MF A01			
7-327,931	14:47734	NTIS, PC A03/MF A01			
7-326,777	14:47735	NTIS, PC A02/MF A01			
7-322,381	14:47736	NTIS, PC A02/MF A01			
7-297,893	14:47749	NTIS, PC A02/MF A01			
7-280,607	14:47750	NTIS, PC A03/MF A01			
7-304,442	14:47772	NTIS, PC A03/MF A01			
A7-292,814	14:48098	NTIS, PC A03/MF A01			
PB–					
89-138762/XAB	14:47298	NTISCP D99			
89-142418/XAB	14:47290	NTIS, PC A15/MF A01			
89-142442/XAB	14:47291	NTIS, PC A07/MF A01			
89-142459/XAB	14:47292	NTIS, PC A17/MF A01			
89-149314/XAB	14:48051	NTIS, PC A04/MF A01			
89-155766/XAB	14:48114	NTISCP D99			
89-159727/XAB	14:46899	NTIS, PC A19/MF A01			
89-160584/XAB	14:47233	NTIS, PC EE03/MF E03			
89-160618/XAB	14:47402	NTIS, PC EE03/MF E03			
89-167936/XAB	14:48092	NTIS, PC EE04/MF A01			
89-167944/XAB	14:47934	NTIS, PC A09/MF A01			
89-169510/XAB	14:47315	NTIS, PC EE05/MF E05			
89-170211/XAB	14:47316	NTISCP D99			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
89-170369/XAB	14:47278	NTIS, PC A19/MF A01			
89-170732/XAB	14:46887	NTIS, PC EE07/MF E07			
89-173041/XAB	14:48219	NTIS, PC A08/MF A01			
89-173231/XAB	14:47962	NTIS, PC A03/MF A01			
89-173371/XAB	14:47205	NTIS, PC A03/MF A01			
89-173611/XAB	14:46911	NTIS, PC A04/MF A01			
89-174239/XAB	14:47226	NTIS, PC A08/MF A01			
89-178594/XAB	14:48030	NTIS, PC A09/MF A01			
89-179931/XAB	14:48052	NTIS, PC A03/MF A01			
89-181093/XAB	14:47935	NTISCP D01			
89-181127/XAB	14:46907	NTIS, PC A04/MF A01			
89-181135/XAB	14:46913	NTIS, PC A07/MF A01			
89-181218/XAB	14:47936	NTIS, PC A03/MF A01			
89-181259/XAB	14:47967	NTIS, PC A03/MF A01			
89-181317/XAB	14:47937	NTIS, PC A03/MF A01			
89-181325/XAB	14:48031	NTIS, PC A02/MF A01			
89-181390/XAB	14:47479	NTIS, PC A03/MF A01			
89-181408/XAB	14:48032	NTIS, PC A02/MF A01			
89-181416/XAB	14:48146	NTIS, PC A02/MF A01			
89-181598/XAB	14:48033	NTIS, PC A03/MF A01			
89-181770/XAB	14:48147	NTIS, PC A03/MF A01			
89-182158/XAB	14:48053	NTIS, PC A04/MF A01			
89-182406/XAB	14:48054	NTIS, PC A10/MF A01			
89-182448/XAB	14:48055	NTIS, PC A03/MF A01			
89-182877/XAB	14:48734	NTIS, PC EE03/MF A01			
89-184055/XAB	14:48093	NTIS, PC EE12/MF A01			
89-184063/XAB	14:47206	NTIS, PC EE12/MF A01			
89-184568/XAB	14:47938	NTIS, PC A11/MF A01			
89-185300/XAB	14:48220	NTIS, PC A06/MF A01			
89-185987/XAB	14:48221	NTIS, PC A07/MF A01			
89-185995/XAB	14:48222	NTIS, PC A05/MF A01			
89-186027/XAB	14:46912	NTISCP D03			
89-186530/XAB	14:47939	NTIS, PC A03/MF A01			
89-187272/XAB	14:48136	NTIS, PC A04/MF A01			
89-187314/XAB	14:47940	NTIS, PC A21/MF A01			
89-187322/XAB	14:47941	NTIS, PC A07/MF A01			
89-187876/XAB	14:47942	NTIS, PC A04/MF A01			
89-187918/XAB	14:47209	NTIS, PC A14/MF A01			
89-187934/XAB	14:48148	NTIS, PC A08/MF A01			
89-187967/XAB	14:47943	NTIS, PC A03/MF A01			
89-187975/XAB	14:48149	NTIS, PC A03/MF A01			
89-188007/XAB	14:47944	NTIS, PC A03/MF A01			
89-188403/XAB	14:47945	NTIS, PC A03/MF A01			
89-188510/XAB	14:46900	NTIS, PC A03/MF A01			
89-188528/XAB	14:48056	NTIS, PC A05/MF A01			
89-188536/XAB	14:47227	NTIS, PC A03/MF A01			
89-188551/XAB	14:47228	NTIS, PC A03/MF A01			
89-188932/XAB	14:48057	NTIS, PC A11/MF A01			
89-189153/XAB	14:47273	NTIS, PC A07/MF A01			
89-189419/XAB	14:47963	NTIS, PC A03/MF A01			
89-189427/XAB	14:48034	NTIS, PC A04/MF A01			
89-189443/XAB	14:47299	NTIS, PC A04/MF A01			
89-189450/XAB	14:47946	NTIS, PC A03/MF A01			
89-189492/XAB	14:47999	NTIS, PC A03/MF A01			
89-189567/XAB	14:47229	NTIS, PC A24/MF A01			
89-189633/XAB	14:48058	NTIS, PC A04/MF A01			
89-189641/XAB	14:47230	NTIS, PC A05/MF A01			
89-189708/XAB	14:48035	NTIS, PC A04/MF A01			
89-189716/XAB	14:47231	NTIS, PC A03/MF A01			
89-189724/XAB	14:48059	NTIS, PC A03/MF A01			
89-189740/XAB	14:48060	NTIS, PC A03/MF A01			
89-189757/XAB	14:48036	NTIS, PC A03/MF A01			
89-189765/XAB	14:48037	NTIS, PC A04/MF A01			
89-189849/XAB	14:47947	NTIS, PC A03/MF A01			
89-189872/XAB	14:47948	NTIS, PC A12/MF A01			
89-189880/XAB	14:47949	NTIS, PC A11/MF A01			
89-189922/XAB	14:46844	NTIS, PC A06/MF A01			
89-190136/XAB	14:47964	NTIS, PC A03/MF A01			
89-190144/XAB	14:47968	NTIS, PC A03/MF A01			
89-190151/XAB	14:48061	NTIS, PC A03/MF A01			
89-190169/XAB	14:48000	NTIS, PC A03/MF A01			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
89-190300/XAB	14:48062	NTIS, PC A04/MF A01			
89-190318/XAB	14:47950	NTIS, PC A10/MF A01			
89-190367/XAB	14:48038	NTIS, PC A12/MF A01			
89-190375/XAB	14:47951	NTIS, PC A09/MF A01			
89-190391/XAB	14:48150	NTIS, PC A05/MF A01			
89-190409/XAB	14:48063	NTIS, PC A09			
89-190896/XAB	14:46906	NTIS, PC A03/MF A01			
89-191043/XAB	14:46924	NTIS, PC A04/MF A01			
89-191415/XAB	14:47029	NTIS, PC EE03/MF A01			
89-191480/XAB	14:46883	NTIS, PC EE02/MF A01			
89-192074/XAB	14:48064	NTIS, PC A09/MF A01			
89-192140/XAB	14:48065	NTIS, PC A14/MF A01			
89-192207/XAB	14:48066	NTIS, PC A07/MF A01			
89-192256/XAB	14:48067	NTIS, PC A19/MF A01			
89-192264/XAB	14:48068	NTIS, PC A09/MF A01			
89-192355/XAB	14:48039	NTIS, PC A03/MF A01			
89-192363/XAB	14:48040	NTIS, PC A11/MF A01			
89-192397/XAB	14:48069	NTIS, PC A06/MF A01			
89-192405/XAB	14:48070	NTIS, PC A06/MF A01			
89-192413/XAB	14:48071	NTIS, PC A03/MF A01			
89-192421/XAB	14:48072	NTIS, PC A03/MF A01			
89-192447/XAB	14:48041	NTIS, PC A06/MF A01			
89-192462/XAB	14:48042	NTIS, PC A07/MF A01			
89-192496/XAB	14:48043	NTIS, PC A07/MF A01			
89-192504/XAB	14:48044	NTIS, PC A16/MF A01			
89-193981/XAB	14:47249	NTIS, PC A07/MF A01			
89-193999/XAB	14:47250	NTIS, PC A15/MF A01			
89-194013/XAB	14:46908	NTIS, PC A08/MF A01			
89-194088/XAB	14:47403	NTIS, PC A07/MF A01			
89-194104/XAB	14:47952	NTIS, PC A04/MF A01			
89-194112/XAB	14:46917	NTIS, PC A05/MF A01			
89-194229/XAB	14:47953	NTIS, PC A19/MF A01			
89-194237/XAB	14:46841	NTIS, PC A05/MF A01			
89-194252/XAB	14:47954	NTIS, PC A04/MF A01			
89-194468/XAB	14:48151	NTIS, PC A06/MF A01			
89-194476/XAB	14:48152	NTIS, PC A06/MF A01			
89-194526/XAB	14:47232	NTIS, PC A16/MF A01			
89-195069/XAB	14:46918	NTIS, PC A04/MF A01			
89-195218/XAB	14:48045	NTIS, PC A05/MF A01			
89-195226/XAB	14:47955	NTIS, PC A05/MF A01			
89-195234/XAB	14:48073	NTIS, PC A04/MF A01			
89-195242/XAB	14:48074	NTIS, PC A05/MF A01			
89-195770/XAB	14:46919	NTIS, PC A03/MF A01			
89-195788/XAB	14:47307	NTIS, PC A09/MF A01			
89-195812/XAB	14:46904	NTIS, PC A04/MF A01			
89-195820/XAB	14:47318	NTIS, PC A06/MF A01			
89-195903/XAB	14:47956	NTIS, PC A03/MF A01			
89-196422/XAB	14:47965	NTIS, PC A08/MF A01			
89-196661/XAB	14:48753	NTIS, PC A16/MF A01			
89-196687/XAB	14:48001	NTIS, PC A14/MF A01			
89-196695/XAB	14:48075	NTIS, PC A03/MF A01			
89-196703/XAB	14:48076	NTIS, PC A05/MF A01			
89-196711/XAB	14:48077	NTIS, PC A04/MF A01			
89-196729/XAB	14:48078	NTIS, PC A05/MF A01			
89-196737/XAB	14:48079	NTIS, PC A05/MF A01			
89-196745/XAB	14:48002	NTIS, PC A04/MF A01			
89-196752/XAB	14:48003	NTIS, PC A04/MF A01			
89-196760/XAB	14:48004	NTIS, PC A06/MF A01			
89-196778/XAB	14:48005	NTIS, PC A06/MF A01			
89-196786/XAB	14:48006	NTIS, PC A04/MF A01			
89-197388/XAB	14:47957	NTIS, PC A03/MF A01			
89-198816/XAB	14:47969	NTIS, PC A25/MF A01			
89-199004/XAB	14:48115	NTISsee individual diskette for order number and price			
89-199541/XAB	14:48116	NTISsee individual diskette for order number and price			
89-202758/XAB	14:47256	NTIS, PC A04/MF A01			
89-203756/XAB	14:47966	NTIS, PC A03/MF A01			
89-204085/XAB	14:46909	NTIS, PC A03/MF A01			
89-204747/XAB	14:48007	NTIS, PC A06/MF A01			
89-204754/XAB	14:48080	NTIS, PC A10/MF A01			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
89-204762/XAB	14:47970	NTIS, PC A04/MF A01			
89-204788/XAB	14:48008	NTIS, PC A05/MF A01			
89-204796/XAB	14:48009	NTIS, PC A04/MF A01			
89-204838/XAB	14:48010	NTIS, PC A03/MF A01			
89-204846/XAB	14:48011	NTIS, PC A11/MF A01			
89-205090/XAB	14:46910	NTIS, PC A03/MF A01			
89-205124/XAB	14:48153	NTIS, PC A03/MF A01			
89-206981/XAB	14:47234	NTIS, PC A07/MF A01			
89-207484/XAB	14:48050	NTIS, PC A99/MF A01			
89-208169/XAB	14:47293	NTIS, PC A17/MF A01			
89-861751/XAB	14:48154	NTISPC N01/MF N01			
89-865091/XAB	14:47958	NTISPC N01/MF N01			
89-865257/XAB	14:47721	NTISPC N01/MF N01			
89-865265/XAB	14:47722	NTISPC N01/MF N01			
89-865323/XAB	14:47375	NTISPC N01/MF N01			
89-865331/XAB	14:47376	NTISPC N01/MF N01			
89-865505/XAB	14:47443	NTISPC N01/MF N01			
89-865661/XAB	14:47300	NTISPC N01/MF N01			
PER–					
165	14:46977	NTIS (US Sales Only), PC A13/MF A01 - OSTI; INIS		DE90601295/JAW	
PEUTZ-E–					
160-2	14:47274	Adviesbureau Peutz en Associes BV, P.O. Box 407, 6500 AK Nijmegen, Netherlands			
PINSTECH–					
110	14:47120	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601679/JAW	
111	14:47117	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601704/JAW	
112	14:47112	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601632/JAW	
113	14:47121	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601680/JAW	
PIRSEM–					
0252	14:46837	NTIS (US Sales Only), PC A03/MF A01		DE89764069/JAW	
1070.1	14:47050	NTIS (US Sales Only), PC A04/MF A01		DE89764078/JAW	
PNL–					
6845	14:47202	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017903/JAW	MF-202
6907	14:48046	NTIS, PC A18/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016584/JAW	MF-502
6924	14:47148	*See* NUREG/CR–5396			
6952	14:47837	NTIS, PC A05/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016807/JAW	MF-507
6956	14:48162	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016579/JAW	MF-403
6959	14:47073	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017753/JAW	MF-261
6969	14:46933	NTIS, PC A08/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016552/JAW	MF-721
6989	14:46978	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016581/JAW	MF-721
PNL-SA–					
16788	14:46979	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016819/JAW	MF-502; MF-506
16832	14:46980	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017242/JAW	MF-814
16877	14:46981	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016818/JAW	MF-802
16884	14:46982	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016821/JAW	MF-512
17011	14:47101	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016824/JAW	MF-522
17193	14:48706	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016826/JAW	MF-310
17246	14:47294	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016829/JAW	MF-372
PPPL–					
2639	14:48659	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016955/JAW	PC-420; PC-427
2644	14:48660	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017747/JAW	PC-421
PPRP-B–					
10	14:47256	*See* PB–89-202758/XAB			
PUPT–					
89-1119	14:48218	*See* N–89-21716			
PUR–					
9016435	14:47244	OSTI; Purdue University, School of Engineering, West Lafayette, IN 47907		TI89016435/JAW	
REG/G–					
1.84-Rev.26	14:47108	NTIS, PC A03/MF A01 - GPO; OSTI; INIS		TI89015527/JAW	
REPT–					
4015.1	14:46911	*See* PB–89-173611/XAB			
89-1A	14:46924	*See* PB–89-191043/XAB			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
RI–					
9225	14:46888	US General Accounting Office, PO Box 6015, Gaithersburg, MD 20877			
RRK–					
89-10	14:48223	NTIS (US Sales Only), PC A03/MF A01		DE90701753/JAW	
89-11	14:48576	NTIS (US Sales Only), PC A03/MF A01		DE90701754/JAW	
SAND–					
88-1218	14:48735	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016674/JAW	MF-705
88-1881C	14:47088	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89011538/JAW	MF-523
88-2744	14:46983	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89014354/JAW	MF-815
88-3307C	14:48522	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016809/JAW	MF-704
88-3338C	14:47444	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016530/JAW	MF-704
89-0139C	14:48690	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017230/JAW	MF-712
89-0166	14:47852	NTIS, PC A04/MF A01 - OSTI		DE89016926/JAW	MF-253
89-0283C	14:48691	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016886/JAW	MF-411
89-0344C	14:47860	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017229/JAW	MF-741
89-0547	14:47723	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016671/JAW	MF-406
89-0571	14:47798	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016670/JAW	MF-414
89-0661C	14:47445	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016884/JAW	MF-701
89-0814C	14:47446	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015407/JAW	MF-704
89-1019C	14:48164	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016885/JAW	MF-703
89-1069C	14:47861	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016812/JAW	MF-741
89-1115C	14:47404	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017231/JAW	MF-404
89-1116C	14:47447	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016882/JAW	MF-704
89-1256	14:47724	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016925/JAW	MF-706
89-1270C	14:48692	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016810/JAW	MF-712
89-1784	14:47848	NTIS, PC A10/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016920/JAW	MF-900
89-1829C	14:47448	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016176/JAW	MF-704
89-1854C	14:47151	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016030/JAW	
89-1875C	14:48523	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016035/JAW	MF-704
89-1878C	14:47152	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016765/JAW	MF-741
89-1954C	14:47767	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017233/JAW	MF-706
89-1964C	14:47725	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016881/JAW	MF-700
89-2009C	14:47040	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016764/JAW	MF-270
89-2121C	14:47916	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017232/JAW	MF-700
89-2136C	14:47207	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016766/JAW	MF-212
SEMR–					
8803	14:47235	Saskatchewan Energy and Mines, 1914 Hamilton St., Regina, Sask., CAN S4P 4V4; $N/C; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1; $10 CAN.			
SER-C-PREPUBL-FASC–					
29	14:48224	NTIS, PC A03/MF A01			
30	14:48225	NTIS, PC A03/MF A01			
32	14:48226	NTIS, PC A03/MF A01			
SERI/SP–					
231-3520	14:47027	NTIS, PC A08/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89009453/JAW	MF-246
SERI/STR–					
211-3562	14:47041	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89009467/JAW	MF-271
SGD–					
534-PT-1	14:48219	*See* PB–89-173041/XAB			
535-PT-1	14:48221	*See* PB–89-185987/XAB			
535-PT-2	14:48222	*See* PB–89-185995/XAB			
SLAC–					
339	14:47815	NTIS, PC A08/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016957/JAW	PC-414
SLAC-PUB–					
5031	14:48418	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016943/JAW	PC-414
5047	14:48320	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016947/JAW	PC-414
5052	14:48321	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016948/JAW	PC-414
5057	14:48357	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89015641/JAW	PC-414
5095	14:48419	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016952/JAW	PC-414
SOQUIP–					
1988	14:47254	SOQUIP (Societe quebecoise d'initiatives petrolieres), 1175, rue de Lavigerie, C.P. 10650, Ste-Foy, PQ, Canada G1V 4P5; $N/C; MF CANMET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1; $10 CAN.			
STF–					
11-A88056	14:47233	*See* PB–89-160584/XAB			

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
19-A88009	14:47402	*See* PB–89-160618/XAB			
SWA–					
88/102	14:48734	*See* PB–89-182877/XAB			
T–					
23539	14:48173	*See* INIS-SU–113/A			
TASC-TR–					
9033-1	14:48751	*See* AD-A–207449/0/XAB			
TKK-KO/LVI–					
B24	14:47275	NTIS (US Sales Only), PC A06/MF A01		DE89914701/JAW	
TM–					
88/17	14:46887	*See* PB–89-170732/XAB			
TR–					
0088(3940-05)-8	14:48237	*See* AD-A–207547/1/XAB			
0088(3940-06)-4	14:48234	*See* AD-A–206457/4/XAB			
0088(3945-03)-2	14:48495	*See* AD-A–207734/5/XAB			
19	14:47387	*See* AD-A–207020/9/XAB			
39	14:48712	*See* AD-A–207190/0/XAB			
832-89	14:48068	*See* PB–89-192264/XAB			
832-93	14:48065	*See* PB–89-192140/XAB			
TR-EL–					
82-4/82(11.102)	14:48015	OSTI; Fish and Wildlife Service, NASA-Slidell Computer Complex, 1010 Gause Blvd., Slidell, LA 70458		TI89016535/JAW	
82-4/82(11.103)	14:48016	OSTI - US Fish and Wildlife Services, 1010 Gause Blvd., Slidell, LA 70458		TI89016533/JAW	
82-4/82(11.99)	14:48014	OSTI - US Fish and Wildlife Service, 1010 Guase Blvd., Slidell, LA 70458		TI89016534/JAW	
TRC-A–					
87-342	14:47969	*See* PB–89-198816/XAB			
TTC–					
1529-R	14:47739	*See* AD-A–207261/9/XAB			
TTKK-LT–					
49	14:47777	NTIS (US Sales Only), PC A04/MF A01		DE89914702/JAW	
UCD/ET–					
88/4	14:48150	*See* PB–89-190391/XAB			
UCID–					
21519-Rev.1	14:48693	NTIS, PC A04/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016678/JAW	MF-421
21528	14:47914	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016681/JAW	MF-706
21673	14:48288	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016717/JAW	MF-705
21676	14:47986	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016716/JAW	MF-702
21679	14:48748	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016700/JAW	
21680	14:48749	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016699/JAW	
21684	14:48707	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016680/JAW	
21687	14:47841	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016682/JAW	
21692	14:47862	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017741/JAW	MF-702
21695	14:48736	NTIS, PC A04/MF A01 - OSTI		DE89016669/JAW	MF-705
21722	14:48754	NTIS, PC A03/MF A01 - OSTI		DE89016668/JAW	MF-705
21723	14:48708	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017750/JAW	MF-742
21737	14:48694	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016679/JAW	MF-406
21739	14:47842	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016675/JAW	MF-706
21765	14:48750	NTIS, PC A04/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016683/JAW	
21767	14:48577	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016677/JAW	MF-705
21768	14:48737	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016715/JAW	MF-705
UCRL–					
100094	14:47405	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017735/JAW	MF-700
100270	14:47726	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017758/JAW	MF-406; MF-413
100357-Rev.1	14:47727	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017739/JAW	MF-706
100403	14:47728	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017551/JAW	MF-706
100530	14:48695	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017759/JAW	MF-420
100547	14:48484	NTIS, PC A03/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017531/JAW	MF-700
100642	14:47768	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017888/JAW	MF-742; MF-706
100695	14:48535	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016524/JAW	MF-706
100768	14:47018	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017546/JAW	MF-132
100784	14:47838	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017781/JAW	MF-706
100804	14:48524	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017737/JAW	MF-705
100835	14:47863	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017736/JAW	MF-741
100862-Rev.1	14:47748	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017541/JAW	MF-712
100943	14:47019	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017547/JAW	MF-132
101192	14:47769	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015773/JAW	MF-706

Report Number	Abstract Number	Source of Availability	GPO Dep.	Order Number	Distribution Category
101228	14:48278	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017543/JAW	MF-700
101297	14:48460	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017530/JAW	MF-712
101322	14:48662	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017532/JAW	MF-706
101395	14:48663	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017534/JAW	MF-700
101396	14:48578	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017535/JAW	MF-700
101436	14:48227	NTIS, PC A02/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89017738/JAW	MF-744
101542	14:47917	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017542/JAW	MF-742
101588	14:48094	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016577/JAW	
101616	14:48525	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017755/JAW	MF-705
101617	14:47864	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017730/JAW	MF-741
101646	14:48696	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017740/JAW	MF-712
101680	14:47865	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017885/JAW	MF-741
101721	14:47850	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017784/JAW	MF-701; MF-706
101753	14:48228	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017782/JAW	MF-700
101777	14:47729	NTIS, PC A02/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017891/JAW	MF-705
21064	14:48155	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016511/JAW	
21156	14:47279	NTIS, PC A06/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017528/JAW	
21166	14:47849	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017545/JAW	MF-706
21225	14:48661	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89017527/JAW	MF-712
53929-88	14:47245	NTIS, PC A13/MF A01; OSTI; INIS; GPO Dep.	E 1.99:	DE89016960/JAW	PC-700; PC-713
UCT/DESE-TR–					
88-3	14:48719	*See* AD-A–207877/2/XAB			
UILU-ENG–					
89-1753	14:48725	*See* DOE/ER/25026–33			
UIUC-HEPG–					
89-4	14:48297	*See* DOE/ER/01195–T12			
89-5	14:48296	*See* DOE/ER/01195–T11			
UIUCDCS-R–					
89-1534	14:48725	*See* DOE/ER/25026–33			
UM-P–					
88/115	14:47554	NTIS (US Sales Only), PC A03/MF A01 - OSTI; INIS		DE90601258/JAW	
UR/CPRC–					
1989	14:47251	Canadian Plains Research Centre, University of Regina, Regina, SK, CAN S4S 0A2; PRICES UPON REQUEST, FUNDS CAN; MF CAN-MET/TID, Energy, Mines and Resources Canada, 555 Booth St., Ottawa, Ont., Canada K1A 0G1; $10 CAN.			
USAFSAM-TR–					
89-9	14:48113	*See* AD-A–207708/9/XAB			
USAMRICD-P–					
88-004	14:48085	*See* AD-A–208149/5/XAB			
UTK-PSL–					
89-1	14:48282	*See* AD-A–207017/5/XAB			
UW-CMRG-R–					
89-106	14:47441	*See* N–89-21286			
VTT-TIED–					
939	14:47280	NTIS (US Sales Only), PC A07/MF A01		DE89914695/JAW	
960	14:47276	NTIS (US Sales Only), PC A05/MF A01		DE89914691/JAW	
967	14:47020	NTIS (US Sales Only), PC A04/MF A01		DE89914694/JAW	
971	14:47277	NTIS (US Sales Only), PC A05/MF A01		DE89914693/JAW	
VTT-TUTK–					
619	14:47778	NTIS (US Sales Only), PC A03/MF A01		DE89914692/JAW	
VTT/RN–					
947	14:46883	*See* PB–89-191480/XAB			
VTT/RR–					
591	14:47029	*See* PB–89-191415/XAB			
WES/TR/EL–					
89-2	14:48018	*See* AD-A–206659/5/XAB			
WHC-SP–					
0084	14:47124	NTIS, PC A07/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015992/JAW	MF-700
0205	14:47113	NTIS, PC A05/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89015993/JAW	MF-700
Y/DX–					
833	14:47377	NTIS, PC A03/MF A01 - OSTI; GPO Dep.	E 1.99:	DE89016900/JAW	MF-706

Order Number Correlation

The correlation list is provided for those organizations that file documents by report number but may receive requests by order number. For more information about a document, refer to the Report Number Index.

Order No.	*Report No.*
DE88755371	ENEA-RT-COMB–87-15
DE88755372	ENEA-RT-TIB–88-3
DE89000759	NIPER–400
DE89000761	NIPER–200
DE89000762	NIPER–308
DE89000764	NIPER–272
DE89000952	DOE/METC–89/6101
DE89000984	DOE/MC/22181–2694
DE89000987	DOE/MC/23288–2697
DE89000990	DOE/MC/22137–2704-Vol.1
DE89005395	DOE/OSTI–4500-Rev.75
DE89009453	SERI/SP–231-3520
DE89009467	SERI/STR–211-3562
DE89010902	DOE/ER–0144/7
DE89011538	SAND–88-1881C
DE89011670	DOE/MC/21023–2716
DE89011675	DOE/MC/23277–2731
DE89011682	DOE/MC/20422–2729
DE89011689	DOE/MC/22012–2726
DE89011694	DOE/MC/24092–2725
DE89011700	DOE/MC/23251–2730
DE89012623	LA-UR–89-1584
DE89013433	DOE/PETC/QTR–88/3
DE89014081	CONF-8909110–4
DE89014354	SAND–88-2744
DE89014439	DOE/CE/15401–T4
DE89015176	MLM-MU–89-68-0001
DE89015178	LA–11570-MS
DE89015201	DOE/ID/12467–3
DE89015269	LA-UR–89-2324
DE89015291	LA-UR–89-2529
DE89015294	LA-UR–89-2506
DE89015296	LA-UR–89-2500
DE89015299	LA-UR–89-2482
DE89015352	CONF-8905197–1
DE89015373	CONF-881190–4
DE89015375	CONF-8906203–1
DE89015407	SAND–89-0814C
DE89015517	DOE/ER/40020–T4
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DE90601325	INIS-mf–11529
DE90601353	DOE-RW–88.103
DE90601395	INIS-XN–185
DE90601420	ANSTO/E–675
DE90601592	ANSTO/E–681
DE90601632	PINSTECH–112
DE90601635	IAEA-TECDOC–505
DE90601639	IWGFPT–31
DE90601678	INIS-GB–199
DE90601679	PINSTECH–110
DE90601680	PINSTECH–113
DE90601704	PINSTECH–111
DE90601725	DOE-RW–87.113
DE90601750	INIS-mf–11536
DE90601776	INIS-mf–11532
DE90601777	INIS-mf–11533
DE90601790	INIS-mf–11535
DE90701451	CEA-N–2599
DE90701452	CEA-TR–2469
DE90701453	CEA-TR–2326
DE90701454	CEA-TR–2327
DE90701455	CEA-TR–2468
DE90701456	CEA-TR–2336
DE90701457	CEA-TR–2374
DE90701458	CEA-TR–2373
DE90701459	CEA-TR–2367
DE90701460	CEA-TR–2433

Order No.	Report No.
DE90701461	CEA-CONF–9774
DE90701462	CEA-CONF–9456
DE90701463	CEA-CONF–9484
DE90701464	CEA-CONF–9455
DE90701549	IPNO-DRE–88-28
DE90701582	IPPJ–895
DE90701583	IPPJ–896
DE90701584	IPPJ–897
DE90701585	IPPJ–898
DE90701616	IPPJ-DT–145
DE90701620	JAERI-M–88-260
DE90701622	JAERI-M–89-011
DE90701623	JAERI-M–89-014
DE90701645	JAERI-M–89-017
DE90701646	JAERI-M–89-029
DE90701676	JAERI–1315
DE90701678	JAERI-M–89-028
DE90701679	JAERI-M–89-032
DE90701699	JAERI-M–89-039
DE90701700	JAERI-M–89-043
DE90701702	KEK–88-16
DE90701703	KEK–88-13
DE90701707	JAERI-M–89-027
DE90701708	JAERI-M–89-042
DE90701709	JAERI-M–89-044
DE90701710	KEK–88-15
DE90701750	JAERI-M–89-050
DE90701751	JAERI-M–89-054
DE90701752	JAERI-M–89-030
DE90701753	RRK–89-10
DE90701754	RRK–89-11
DE90701755	IPPJ–904
DE90701757	IPPJ–902
DE90701758	IPPJ–901
DE90701779	INS-T–487
DE90701780	KURRI-TR–314
DE90701781	JAERI-M–89-057
DE90701782	JAERI-M–89-036
DE90701783	JAERI-M–89-019
DE90701784	JAERI-M–89-021
DE90701785	JAERI-M–89-040
DE90701798	IPPJ-DT–150
DE90701799	IPPJ-DT–151
DE90701894	KEK-PR–88-3
DE90702240	FRNC-TH–3498
DE90702692	ETDE-mf–0702692
DE90702693	ETDE-mf–0702693
DE90702694	ETDE-mf–0702694
DE90702695	ETDE-mf–0702695
DE90702697	ETDE-mf–0702697
DE90702726	ETDE-mf–0702726
DE90702738	KFK-PEF–49
DE90702746	INIS-mf–11999
DE90702748	DFVLR-FB–89-16
DE90702751	ETDE-mf–0702751
DE90702753	INIS-mf–12001
DE90702759	INIS-mf–11997
DE90702760	DLG–538030
DE90702767	BONN-IR–88-62
DE90702768	BONN-IR–88-43
DE90702776	ETDE-mf–0702776
DE90702783	DLR-FB–89-33
DE90702784	DLR-FB–89-35
DE90702785	Juel–2277
DE90702801	NUKEM-FuE–88034
DE90702816	ETDE-mf–0702816
DE90702817	ETDE-mf–0702817
DE90702823	IBP-GB–14/86
DE90702824	IBP-SA–3/85
DE90702833	ETDE-mf–0702833
DE90702841	Juel–2262
DE90702844	Juel–2264
DE90702845	KFK–4477
DE90702846	Juel-Spez–494
DE90702847	GSI–89-1
DE90702849	GRS-F–173
DE90702850	KFK–4574
DE90702851	KFK–4592
DE90702886	KFK-PWAB–1
DE90702887	IPP–2/297
DE90702888	IPP–6/277
DE90703167	HMI-B–466
DE90703171	GRS-F–172
TI89015412	NUREG/CR–5396
TI89015527	REG/G–1.84-Rev.26
TI89015547	NUREG/CR–4234-Vol.2
TI89016435	PUR–9016435
TI89016533	TR-EL–82-4/82(11.103)
TI89016534	TR-EL–82-4/82(11.99)
TI89016535	TR-EL–82-4/82(11.102)
TI89016551	OCS/EIS/EA/MMS–89-0053
TI89016556	NUREG/CR–5338
TI89016693	DOE/IG–0271
TI89016875	NUREG–1365
TI89017620	OCS/EIS/EA/MMS–89-0061
TI89017795	BUMINES–9017795

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TR Turkey
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TW Taiwan
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UG Uganda
US United States of America (USA)
UY Uruguay

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